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MINISTRY OF WORKS, HOUSING AND REHABILITATION

(Central Boilers Board)

NOTIFICATION

New Delhi, the 1st January 1963

G.S.R. 510.—The following draft of certain Regulations, further amend the Indian Boiler Regulations, 1950 which the Central Boilers Board proposes to make in exercise of the power conferred by section 28 of the Indian Boilers Act, 1923 (5 of 1923), is published as required by sub-section (1) of section 31 of the said Act, for the information of all persons likely to be affected thereby; and notice is hereby given that the said draft will be taken into consideration on or after the 31st July, 1963.

Any objection or suggestion which may be received from any person with respect to the said draft before the date so specified will be considered by the Central Boilers Board. Such objections or suggestions should be addressed to the Secretary, Central Boilers Board, Ministry of Works and Housing, North Block, New Delhi.

DRAFT REGULATIONS

1. These regulations may be called the Indian Boiler (Amendment) Regulations, 1962.

2. In the Indian Boiler Regulations, 1950—

(1) in regulation 2—

(*i*) in clause (*c*), for the words "five gallons" the figures, words and brackets "22·75 litres (five gallons)" shall be substituted ;

(*ii*) for clause (*k*), the following clause shall be substituted, namely :—

"(k) "Steam pipe" means any pipe through which steam passes from a boiler to a prime-mover or other user or both, if,—

(*i*) the pressure at which steam passes through such pipe exceeds 3·5 kilograms per square centimetre above atmospheric pressure ; or

(*ii*) such pipe exceeds 254 millimetres in internal diameter ;

and includes in either case any connected fitting of a steam-pipe":

(2) in regulation 4—

(*i*) in clause (*c*).—

(*a*) in sub-clause (*iii*), for the figures and words "3/4 inch to the foot and, in the case of small boiler of not less than 1½ inches to the foot", the words "1/20th of full size and, in the case of small boilers of not less than 1/10th of full size", and for the figures and words "1/4 inch to the foot" the figures and words "1/15th of full size" shall respectively be substituted,

(*b*) in sub-clause (*iv*), for the words "their ultimate tensile breaking strength in tons per square inch of section", the words "their tensile strength" shall be substituted;

(*ii*) in clause (*d*), for the particulars under the general heading " Maker's Name " the following particulars shall be substituted, namely :—

Makers' Name

Work's Number——————————————————Year of make ——————

Tested to——————————————————Kg/cm²/(lb/sq. in) ——on——————

W.P.——————————————————Kg/cm² (lb./sq. in.) ——————————

Inspecting Officer's or Inspecting Authority's Official Stamps.

(3) in regulation 5, for the figures and words " more than 26 tons per square inch " and for the words " In such cases the values of tensile and shear strength shall not be more than 26 and 21 tons per square inch for steel, and 21 and 18 tons per square inch for iron. For iron across the grain the tensile strength may be 18 tons per square, inch ", the words, figures and brackets " more than 41 kilograms per square millimeter (26 tons per square inch)", and " In such cases the values of tensile and shear strengths shall not be more than 41 and 33 kilograms per square millimeter (26 and 21 tons per square inch) for steel and 33 and 28 kilograms per square millimeter (21 and 18 tons per square inch) for iron. For iron across the grain the tensile strength may be 28 kilograms per square millimeter (18 tons per square inch)" shall respectively be substituted ;

(4) in Regulation 10, for clause (*c*), the following paragraph shall be substituted, namely :—

" When steels are intended for service temperatures over 371°C (700°F), the silicon content shall be not less than 0·10 per cent or alternatively, the material shall pass the proof test for creep quality of carbon steel plates of boiler quality."

(5) for the table under Regulation 12, the following table shall be substituted, namely :—

Schedule of percentage of Rolling weight tolerances for boiler plates.

Thickness	Width								
	Under 1219mm (18 in.)	1219mm (48 in.) to under 1524mm (60 in.)	1524mm (60 in.) to under 1829 mm (72 in.)	1829mm (72 in.) to under 2134 mm (84 in.)	2134mm (84 in.) to under 2438 mm (96 in.)	2438mm (96 in.) to under 2743 mm (108 in.)	2748mm (108 in.) to under 3048 mm (120 in.)	3048mm (120 in.) to under 3353mm (132 in.)	3353 (132 in.) and over
	%	%	%	%	%	%	%	%	%
6mm (¼ in.) to under 8mm (5/16 in.)	5	5	5	7	9	12	12	..	..
8 mm (5/16 in.) to under 10mm (⅜ in.)	5	5	5	6	7·5	10	11	12	..
10mm (⅜ in.) to under 11mm (7/16 in.)	5	5	5	6	6	8	9	11	15
11mm (7/16 in.) to under 13mm (½ in.)	5	5	5	5	6	7·5	8	9	12
13mm (½ in.) to under 16mm (⅝ in.)	5	5	5	5	6	6	7·5	9	10
16mm (⅝ in.) to under 19mm (¾ in.)	5	5	5	5	5	5	7	8	9
19mm (¾ in..) to under 25mm (1 in.)	5	5	5	5	5	5	6	7	8
25mm (1 in) to under 51 mm (2 in.)	5	5	5	5	5	5	5	6	7

All the above margins will be taken over net theoretical weight.

(6) in Regulation 15, in clause (b).—

(*i*) in sub-clause (*i*), for the figures and abbreviation " 8 in". and "2 in", the figures and abbreviations and brackets " 203 mm (8 in)", and "51 mm (2 in)" shall respectively be substituted ;

(*ii*) in sub-clause (*ii*), for the figure and words " in inch diameter " in the two placels where they occur, the figures, words and brackets " 25 millimeteres (1 inch)" and for the figures and words "1/4 square inch ", the figures, words and brackets " 161 square millimeteres (1/4 square inch)", shall be substituted ;

(7) in Regulation 16, for the figures and words "4 tons per square inch ", the figures words, abbreviations and brackets "6·3 Kilograms per sq. mm. (4 tons/sq. in)" shall be substituted, and for the table below that Regulation, the following table shall be substituted, namely :—

Description	Ultimate tensile stress kg/mm²	Ultimate tensile stress tons/sq. in.	Minimum Elongation per cent*			Bend Test Radius of Bend T = Thickness or diameter
			Test piece A 203 mm (8 in.) guage length	Test piece†	Test piece B	
Plates for Shell. butt-straps, gussets and stays.	41—57	26—36	23 for 41-47 kg/mm² (26-30 tons/sq. in.) 20 for 44-50 kg/mm² (28-32 tons/sq. in) 20 for 47-57 kg/mm² (30-36 tons sq. in.)	21 for 41-47 kg/mm² (26-30 tons/sq. in.) 18 for 44-50 kg/mm² (28-32 tons/sq. in.) 18 for 47-57 kg/mm² (30-36 tons/sq. in.)	—	1T for 41-47 kg./mm² (26-30 tons/sq. in.) 1½T for 44-50 kg/mm² (28-32 tons/sq. it 1½ T for 47-57 kg/mm² (30-36 tons/sq. in.)
Plates for flanging & for furnaces.	33—50	24—32	23 for 38-47 kg/mm² (24-30) tons/sq. in.) 20 for 44-5 kg/mm² (28-32 tons/sq. in.)	21 for 38-47 kg/mm² (25-30 tons/sq. in.) 18 for 44-50 kg/mm² (28-32 tons/sq. in).	— —	1T for 38-47 kg/mm² (24-30 tons/sq. in.) 1½T for 44-50 kg/mm² (28-32 tons/sq. in.)
Plate for forge welding	38—47	24—30	23 for 38-47 kg/mm² (24-3 tons/sq. in.)	21	—	1T for 38-47 kg/mm² (24-30 tons/sq. in.)
Sections	41—47 or 44—52	26—30 or 28—33	23 for 41-47 kg/mm² (26-30 tons/sq. in.) 20 for 44-52 kg/mm² (28-33 tons/sq. in.)	—	—	1T for 41-47 kg/mm² (26-30 tons/sq. in. 1½ T for 44-52 kg/mm² (28-33 tons/sq. in.)
Bars for bar strays.	41—57	26—36	..	25 for 41-47 kg/mm² (26-30 tons/sq. in.) 22 for 47-57 kg/mm² (30-36 tons/sq. in.)	30 for 41-47 kg/mm² (26-30 tons/sq. in.) 27 for 47-57 kg/mm² (30-36 tons/sq. in.)	1½T
Bars for screwed strays	38—44 or 41—47	24—28 or 26—30	..	25	30	—
Bars for rivets.	38—44 or 41—47	24—28 or 26—30	..	25	30	—

*For materail under 10 millimates (⅜ in.) in thickness reduce minimum percentage of elongation by 3.
†Machined in the case of Plates.

In
words and brackets "45 millimeters (1-3/4 inches)" shall be substituted ;

(9) in Regulation 19—

(*i*) in clause (*a*), for the figures and words " ¼ inch ", the figures, words and brackets " 38 millimeteres (¼ inch) " shall be substituted ;

(*ii*) in clause (*b*), for the figures and words " 0·5 inch ", and "1 inch ", the figures, words and brackets " 13 millimeters (0·5 inch)", and "25 millimeters (1 inch)", shall respectively be substituted ;

(10) in Regulation 20, in clause (*a*), for the figures and words " 2½ tons ", the figures, words and brackets " 2540 kilograms (2½ tons) " shall be substituted ;

(11) in Regulations 28 and 30, for the figures and words " 21 and 25 tons per square inch ", the figures, words, brackets and abbreviations " 33 and 39 kilograms per square millimeter (21 and 25 per square inch)", shall be substituted ;

(12) in Regulation 32—

(*i*) in clause (*a*), for the figures and words " 21½ tons per square inch ", the figures, words and brackets "33·86 kilograms per square millimeter (21½ tons per square inch)", shall be substituted ;

(*ii*) in clause (*b*), for the figures and word " 1 inch" the figures, words and brackes "25 millimeters (1 inch)", shall be substituted;

(13) In Regulation 33—

(*i*) in clause (*d*), for the words and figures " shall be not less than 3 inches at the end and 1½ inch at each side," the words, figures and brackets," shall not be less than 7 millimeters (3 inches at the ends and 38 millimeteres (1½ inch) at each side" shall be substituted ;

(*ii*) in clause (*e*), for the figures, words and abbreviations " 14 tons per sq. in." the figures, words and abbreviations " 22 kilograms per square millimeter (14 tons per square inch)", shall be substituted ;

(*iii*) in clause (f), for the words, brackets and abbreviation " One hot (temperature between 1200°F and 1400°F), the words, brackets and abbreviatons "One hot (temperature between 649°C and 760°C or (1200°F and 1400° F)", shall be substituted;

(14) in Regulation 34,—

(*i*) for the table under sub-clause (e), the following table shall be substituted, namely:—

Tensile properties.

	Unturned rods—Rods 32 millimeters (1-1/4 in.) in dia.	Turned rods—Rods above 32 millimeters (1¼ in.) in dia.
Minimum tensile strength .	2278 kg/cm². (32,400 lbs./sq. in.)	2278 kg/cm.² (32,400 lbs/sq. in.)
Elongation, minimum percent in 51 mm (2 in.) gauge length.	40	45

(*ii*) for clause (*g*), the following clause shall be substituted, namely:—

"(*g*) A piece of rod 2 millimeter (1 in.) long shall be placed on end and hammered or crushed down cold to a thickness of 10 millimeters (3/8 in.) without showing either crack or flow on the circumference of the resulting disc."

15) In Regulation 35,—

(*i*) in sub-Regulation (1)—

(*a*) in clause (*a*), for the words, figures, brackets and abbreviation "shall be not less than 14·50 tons (32,480 lbs.) per square inch with and elongation not less than 50 per cent with 2 in.", " shall be not less than 14 tons (31,360 lbs.) per square inch", and " more than one ton (2240 lbs.) per square inch", the words, figures, brackets and abbreviations " shall be not less than 22·8 kilograms per square millimete

(14·5 tons per sq. in.) with an elongation not less than 50 per cent with 51 millimetters (2 in.)" " shall be not less than 22 kilograms per square millimeter (14 tons per sq. in.)" and " more than 1·6 kilograms per square millimeter (one ton per sq. in.)" shall respectively be substituted;

(*b*) in clause (i), the words, figures and abbreviation "hydraulic pressure of 750 lbs per square inch", the words, figures, brackets and abbreviations "hydraulic pressure of 52·5 kilograms per square centimeter (750 lbs. per sq. in.)" shall be substituted;

(*ii*) in sub-regulation (2)—

(*a*) for clause (d), the following clause shall be substituted, namely:—

(*d*) *Tolerances.*—The tubes shall be solid drawn and shall be concentric within the working margins for thickness given below. The tubes shall be straight and unless otherwise ordered they shall be of uniform diameter throughout.

The working margins shall be as follows:—

On length ±1·6 mm. (1/16 in.)

On thickness ±five percent of the specified thickness

On external diameter ±0·13 mm. (·005 in.)

(*b*) in clause (f), for the words, figures and abbreviations "hydraulic pressure of 750 lbs. per sq. in.", the words, figures, brackets and abbreviations "hydraulic pressure of 52·5 kilograms per square centimeter (750 lbs. per sq. in.)" shall be substituted;

(*ii*) for sub-clause (iv) of clause (d), the following sub-clause shall be substituted, namely:—

(*iv*) *Length.*—The length of the tube shall be not less than the nominal length, but may exceed it by the amount given below:—

Upto and including 9 meters (30 ft.) . 3 millimeters (1/8 in.)

Over 9 meters (30 ft.) . . . 6 millimeters (1/4 in.)".

(16) For regulation 38, the following shall be substituted, namely:—

38. *Tensile Test.*—Test pieces cut from the ends of the selected tubes shall comply with the following requirements:—

	Ultimate tensile stress		Minimum elongation per cent			
			On 203 milimeters (8 inches)		On 51 milimeters (2 inches)	
	Not less than	Not more than	6mm (1/4 in.) thick & over	Less than 6mm (1/4 in.) thick	6mm (1/4 in.) thick & over	Less than 6mm (1/4in. thick
Strip cut from tubes and tested in their curved condition.	31·5kg/mm.² (20 tons per sq. in.)	44kg/mm.² (28 tons per sq. in.)	20	18	30	28
Test lengths taken from finished tubes (ends to be plugged for grips.)	31·5kg/mm.² (20 tons per sq. in.)	44kg/mm.² (28 tons per sq. in.)	25	23	..	..

(17) For regulation 39, the following regulation shall be substituted, namely:—

39. *Flattening Test.*—A ring not less than 51 millimeters (2 inches) in length cut from one end of each selected tube shall be flattened between two parallel flat surfaces, the width of which shall be not less than 1½ times the outside diameter of the tube. When the pressure is released, the interior surfaces of the test piece (at the middle)

shall remain at the following distances apart and the test piece shall then show no sign of crack or flaw:—

Tubes over 3 millimeters (0·128 inch) in thickness	Not more than twice the thickness of tubes.
Tubes upto and including 3 millimeters (0·128 inch)	Until the interior surfaces meet at the middle.

The flattening test carried out in accordance with any other standard code may be accepted in which case the code adopted shall be specified.

(18) For the table in Regulation 40, the following table shall be substituted, namely:—

Thickness of tube	Increase in diameter percent
5 millimeters (0·192 inches) and thinner	15
Thicker than 5 millimeters (0·192 inch) upto and including 6 millimeters (0·252 inch).	12
Thicker than 6 millimeters (0·252 inch)	9·5

(19) in Regulation 43,—

(*i*) in clause (b), for the words, figures and symbol " not less than 6 inch", the words, figures, brackets and abbreviations "not less than 150 mm (6 in.)" shall be substituted;

(*ii*) for clause (d), the following clause shall be substituted, namely:—

" (*d*) *Tolerances.*—The tubes shall be of the dimensions specified, straight, cylindrical, of uniform thickness and external diameter throughout, subject to the working margins given in the table below :

(i) *Diameter.*—The external diameter of the tubes measured at any point shall be within the following tolerances.

Outside diameter of tubes	Tolerances
Upto and including 64 millimeters (2-1/2 in.) .	+0·4 millimeter (1/64 in.) —0·8 millimeter (1/32 in.)
Over 64 millimeters (2-1/2 in.) . . .	±1%

(ii) *Thickness.*—The thickness of the tubes shall be within the following tolerances:—

Outside diameter of tubes	Tolerances
Upto and including 64 millimeters (2-1/2 in.) .	+17-1/2% —7-1/2%
Over 64 millimeters (2-1/2 in.) . . .	+15% —5%

Where the ends of the tubes are swelled or reduced the thickness at the ends may be decreased below or increased above the nominal thickness of tubes by an amount in proportion to the percentage of such swelling or reduction and, in addition to this allowance, the tolerances relating to thickness shall also apply.

(iii) *Length.*—The tubes shall be not less than the nominal length but may exceed it by the amount given below:—

Upto and including 9 meters (30 feet) . .	3 millimeters (1/8 in.)
Over 9 meters (30 feet)	6 millimeters (1/4 in.)

(i) in clause (b), for the words and figures "not less than 2 inches", the words, figures and brackets "not less than 51 millimeters (2 inches)" shall be substituted;

(ii) for the table in clause (c), the following table shall be substituted, namely:—

Thickness of Tube	Increase in diameter per cent
5 millimeters (0·192 inch and thinner) . .	15
Thicker than 5 millimeters upto and including 6 millimeters (0·252 inch)	12
Thicker than 6 millimeter	9·5

(21) in Regulation 48,—

(i) for clause (b), the following clause shall be substituted, namely:—

"(b) *Heat Treatment*.—The tubes shall be normalised at a temperature between 920°C (1688°F) and 960°C (1760°F)."

(ii) for the tables in sub-clause (i), (ii) and (iii) in clause (c), the following tables shall respectively be substituted, namely :—

(i)

Type of Tube . .	Outside diameter of Tubes .	Tolerance
Hot finished . . .	Upto and including 64mm (2-1/2 in.)	+0·4 mm (1/64 in.) —0·8 mm (1/32 in.)
	Over 64 mm (2-1/2 in.) . .	±1%
Cold drawn . . .	All sizes	+0 —1%

(ii)

Type of Tube . . .	Outside diameter of Tubes .	Tolerance
Hot finished . . .	Upto and including 64 mm (2-1/2 in.)	+17-1/2% —7-1/2%
	Over 64 mm (2-1/2 in.)	+15% —5%
Cold drawn . . .	All sizes	+10% —5%

(iii)

Upto and including 9 meters (30 ft.) . .	. . . 3mm (1/8 in.)
Over 9 meters (30 ft.)	. . . 6mm (1/4 in.)

(22) In Regulation 49,—

(i) in clause (b), for the words and figures "not less than 2 inches", the words, figures and brackets "not less than 51 millimeters (2 inches)" shall be substituted;

(ii) for the table in clause (c), the following table be

Thickness of Tube	Increase in diameter per cent
3 millimeters (0·128 inches) and thinner	12-1/2
Thicker than 3 millimeters upto and including 5 millimeters (0·192 inches)	9-1/2
Thicker than 5 millimeters (0·192 in.)	6½

(23) in Regulation 53,—

(i) for the tables in sub-clauses (i) and (ii) of clause (c), the following tables shall respectively be substituted, namely :—

(i)

Type of Tube	Outside diameter of tube	Tolerance
Hot finished . . .	Upto and including 64 mm (2½ inch) .	+0·4mm (1/64 in.) —0·8mm (1/32 in.)
	Over 64 mm (2½ inch) . . .	+1% —1%
Cold drawn . . .	All sizes	+0% —1%

(ii)

Type of Tube	Outside diameter of tube	Tolerance
Hot finished . . .	Upto and including 64 mm (2½ inch) .	+17½% —7½%
	Over 64 mm (2½ inch) . . .	+15% —5%
Cold drawn . . .	All sizes	+10% —5%

(ii) for sub-clause (iii) of clause (c), the following sub-clause shall be substituted,

(iii) *Length.* The length of the tubes shall be not less than the nominal length but may exceed it by the amount given below :—

Upto and including 9 meters (30 ft.)	3mm (1/8 inch).
Over 9 meters (30 ft.)	6mm (1/4 inch)

(24) in Regulation 54,—

(i) in clause (b), for the words and figures "not less than 2 inches", the words, figures and brackets "not less than 51 millimeters (2 inches)" shall be substituted ;

(ii) for the table in clause (c), the following table shall be substituted, namely :—

Thickness of Tube	Increase in diameter per cent
3 millimeters (0·128 inch) and thinner	12½
Thicker than 3 millimeters upto and including 5 millimeters (0·192 inch)	9½
Thicker than 5 millimeters	6½

In 57, for
"NOT EXCEEDING 850°F (454°C)", the words, figures, abbreviations and brackets "NOT EXCEEDING 454°C (850°F)" shall be substituted ;

(26) In Regulation 58,—

(*i*) in clause (*c*), for the figures, abbreviations and brackets "750°F (399°C)" in the two places where they occur and "850°F (454°C)", the figures, abbreviations and brackets "399°C (750°F) and 454°C (850°F) shall respectively be substituted ;

(*ii*) for clause (*f*), the following clause shall be substituted, namely :—

"(*f*) *Length.*—The length of each tube shall be not less than the nominal length, but may exceed it by the following amounts :—

Nominal Length	Tolerance
Upto and including 9m (30 ft.)	3 mm (1/8 in.)
Over 9m	6 mm (1/4 in.)";

(27) In regulation 59 (*i*) in clause (*b*) for the figures, words and abbreviations, 4 inch, 1/8 in. and ¼ in., the following figures, abbreviations and brackets shall be substituted, namely :—

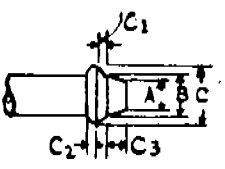
102mm (4 in), 3mm (1/8 in.) and 13mm (1 /2 in.)

(*ii*) in clause (*c*), for the figure and abbreviation, 2½ inch the following figures, abbreviations and brackets shall be substituted, namely :—

64mm (2½ in.)

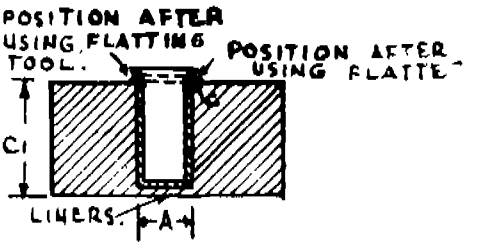
(28) (*i*) For the portion of clause (*b*) above the Table in Regulation 59, the following clause shall be substituted, namely :—

(*b*) *Flange Test.*—(*i*) A section of the tube not less than 102 millimeters (4 inches) in length shall be capable of having a flanged turned over at a right angle to the body of the tube without cracking or showing flaws. This flange, as measured from the outside of the tube, shall not be less than 3 millimeters (1/8 in.) nor more than 13 millimeters (½ in). Within these limits, the width of the flange shall be not less than the following :—



A = OD OF TUBE LESS C4.
B = OD OF TUBE LESS C2
C = OD OF TUBE PLUS C5.

WHERE C1 = 6 MM. OR (1/4 IN.)
C2 = 10 MM. OR (3/8 IN.)
C3 = 19 MM. OR (3/4 IN.)
C4 = 16 MM. OR (5/8 IN.)
C5 = 5 MM OR (3/16 IN.)



A = OD OF TUBE PLUS C
C = 0·8 MM. OR 1/32 IN.
C1 = 108 MM. OR 4¼ IN.

DIE BLOCK & FLARING TOOL

(*ii*) In π the , it is
Fig. below be used.

(*iii*) (*c*) *Crush Test.*—When required by the Inspecting Authority, crushing test shall be made on sections of tube 64 millimeters (2½ in.) in length which shall stand crushing longitudinally, without cracking, spliting or openirg at the weld, as follcws :—

Wall thickness of tube	Height of crushed section	
	Type A Tubes	Type C Tubes
3·4mm (·135 In.) and under	19mm (¾in.) or until outside folds are in contact.	Crush tests not required.
Over 3·4mm (·135 in.) .	32mm (1¼ in.)	

Slight surface checks shall not be cause for rejection.

(29) for the table below Regulation 60, the following table shall be substituted, namely :—

Tensile Requirements

Tensile strength min.	Type A 3304 kg/cm² (47,000 lbs/sq. in.)	Type C 4218 kg/cm² (60,000 lbs/sq. in.)
Yield point min.	1828 kg/cm² (26,000 lbs/sq. in.)	2601 kg/cm² (37,000 lbs. /sq. in.)
Elongation in 51 mm (2") min. per cent .	35	30
For longitudinal strip tests a deduction for each 0·8 mm (1/32 in.) decrease in wall thickness below 8mm (5/16 in) from the basic minimum elongation of the following percentage.	1·75	1·50

(30) For regulation 61, the following regulation shall be substituted namely :—

61. *Hydraulic Test.*—(*a*) Each tube shall be tested at the Maker's Works and shall withstan for a minimum of 10 seconds a hydraulic test pressure which shall impose a minimum fibre stress of 1125 kg/cm² (16,000 lbs/sq. in.) and not exceeding 1687 kg/cm² (24,000 lbs/sq. in.) for type A and not exceeding 1828 kg/cm² (26,000 lbs./sq. in.) for type C as determined by the following formula :—

$$P = \frac{2ts}{D}$$

Where P = Hydraulic test pressure
s = Fibre stress
D = Outside diameter of tube
t = Thickness of tube wall

(*b*) Tube shall be struck near both ends while under the test pressure with a 1 kilogram ·2 lbs) hammer or its equivalent.

(31) In Regulation 62, in clause (*b*) for the figures and abbreviations "1 in.", the figures, words, brackets and abbreviations "25 millimeters (1 in.)" shall respectively be substituted ;

(32) For the table below clause (*d*) of Regulation 64, the following table shall be substituted, namely :—

Outside diameter of tube	On diameter		On thickness		On length	
	Plus	Minus	Plus	Minus	Plus	Minus
Under 64mm (2½ in.) .	0·4 mm (1/64 in.)	0·8 mm (1/32 in.)	Percent 10	Percent 10	3mm (1/8 in.)	0
64mm and over . .	Percent 1	Percent 1				

(33) for the table below clause (*c*) of Regulation 65, the following table shall be substituted, namely :—

Thickness of tube	Increase in diameter percent
Upto 3·3 millimeters (0·128 inch)	9·5
Above 3·3 millimeters to 4·9 millimeters (0·192 in.)	7·5
Above 4·9 millimeters	5·0

(34) in Regulation 67, for the figures, abbreviations and word "1000 lbs. per sq. in.", the figures, abbreviations, brackets "70 kg/cm² (1000 lbs/sq. in.)" shall be substituted ;

(35) in clause (*d*) of Regulation 68, for the portion beginning with "the working margin shall be as follows " and ending with "plus or minus one per cent", the following shall be substituted namely :—

The working margin shall be as follows :—

On thickness—plus or minus 10%

On external dia. for tubes under 64 mm (2½ in.)—plus 0·4mm (1/64 in.) and minus 0·8mm (1/32 in.)

On external dia. for tubes 64 mm (2½ in.) and larger—plus or minus 1 percent.

(36) For the table below clause (*a*) of regulation 69, the following table shall be substituted, namely :—

	Ultimate Tensile Strength		Elongation percent on 203mm (8 in.)
	Not less than	Not more than	
Strips cut from the tubes clear of the welds and tested in their curved condition.	31·5 kg/mm² (20 tons/sq. in.)	38·0 kg/mm² (24 tons/sq. in.)	10
Tested lengths taken from finished tubes (ends of tubes to be plugged for grips).	31·5 kg/mm² (20 tons/sq. in.)	38·8 kg/mm² (24 tons/sq. in.)	12½

(37) For the table below regulation 70, the following table shall be substituted, namely :—

Thickness of Tube	Increase in diameter percent
Upto 5 millimeters (0·192 inch)	2½
Above 5 millimeters	1½

(38) in Regulation 71, for the figures and abbreviation "2 in." and "1½ in." the figures, words and brackets "51 millimeters (2 inches)" and "41 millimeters (1½ inches)" shall respectively be substituted ;

(39) in Regulation 72, for the figures and abbreviations "1000 lbs./sq. in.", the figures, abbreviations and brackets "70 kg./cm² (1000 lbs./sq. in.)" shall be substituted ;

(40) For Regulation 73, the following regulation shall be substituted, namely :—

73. *Scope.*—Steel castings shall be of the following grades.

Grade	Ultimate Tensile Stress, Minimum
A	44·0 kg/mm² (28 tons/sq. in.)
B	50·0 kg/mm² (32 tons/sq. in.)
C	55·0 kg/mm² (35 tons/sq. in.)

(41) In Regulation 77, for the table under clause (*a*), the following table shall be substituted namely :—

	Grade		
	A	B	C
Ultimate tensile stress not less than.	44kg/mm² (28 tons/sq. in.)	50·0 kg/mm² (32 tons/sq. in.)	55 kg/mm² (35 tons/sq. in.)
Yield stress or 0·5% proof stress not less than.	22 kg/mm² (14 tons/sq. in.)	25·2 kg/mm² (16 tons/sq. in.)	27·5 kg/mm² (17·5 tons/sq. in.)
Elongation, percent not less than.	22	20	15

(42) For Regulation 78, the following regulation shall be substituted, namely :—

78. *Bend test.*—Cold bend tests shall be made upon test pieces having a rectangular section of 25mm wide by 19mm thick (1 in. wide by 3/4 in. thick). The test pieces shall be machined and the edges rounded to a radius of 1·6mm (1/16 in.). The test pieces shall be bent over the thinner section.

Bend tests may be made by pressure or by blows and the test pieces shall without fracture withstand being bent round a former having a radius of 25 mm (1 in.) through an angle not less than that given in the following table :—

Grade of Casting	Angle of bend—minimum
A	120°
B	90°
C	No test

(43) For Regulation 83, the following regulation shall be substituted, namely :—

83. *Tensile tests.*—The ultimate tensile stress and elongation shall be between the limits of 38·0 kg/mm² (24 tons/sq. in.) and 60·0 kg/mm² (38 tons/sq. in.) and 33% and 19% respectively determined on standard Test piece C or subsidiary standard Test piece (See Appendix B).

Should a tensile test piece break outside the middle half of the test gauge length the test may, at the manufacturer's option, be discarded and another test be made of the same forging.

(44) For Regulation 84, the following regulation shall be substituted, namely :—

84. *Bend tests.*—(*a*) Bend test pieces shall be of rectangular cross section machined to a finished size of 25 millimeters wide by 19 millimeters thick (1 inch wide by 3/4 inch thick). In the case of headers, bend test pieces may be cut transversely 1½T wide by T thick where T is the thickness of the headers. The edges shall be rounded to a radius of 1·6 millimeters (1-1/6 inch). The test pieces shall be bent over the thinner Section.

(*b*) Test pieces shall be bent when cold through an angle of 180° without fracture, the internal radius of the bend being not greater than that specified in the table below, for the 25 mm wide by 19 mm thick (1 inch by 3/4 inch thick) test piece and not more than 1½T for the full thickness test piece.

Ultimate tensile stress	Internal radius of bend
Upto 50·0 kg/mm² (32 tons/sq. in.)	6mm (¼ in.)
Above 50·0 kg/mm² and upto 56 kg/mm² (36 tons /sq. in.)	10mm (3/8 in.)
Above 56·0 kg/mm² and upto 60·0 kg./mm² (38 tons/sq. in.)	16 mm (5/8 in.)

(45) in Regulation 88,—

(i) for the table in clause (*a*), the following table shall be substituted, namely :—

Diameter of Test Bar	Limits on Diameter	Over all Length	Main cross-sectional thickness of castings represented
15·24mm . . .	±1·1 mm	254mm	Not exceeding 10mm
22·125mm . . .	±1·625mm	381mm	Over 10 mm and not exceeding 19mm
30·48mm . . .	±2·25mm	533mm	Over 19mm and not exceeding 29mm
40·6mm . . .	±2·5mm	533mm	Over 29 mm and not exceeding 41mm
53·3mm . . .	±2·5mm	686mm	Over 41mm

OR

Diameter of Test Bar	Limits on Diameter	Over all Length	Main cross-sectional thickness of castings represented
0·6 in . . .	±0·045 in	10 in.	Not exceeding 3/8 in.
0·875 in. . . .	±0·065 in.	15 in.	Over 3/8 in. and not exceeding 1½ in.
1·2 in. . . .	±0·090 in.	21 in.	Over ⅞ in. and not exceeding 1-1/8 in.
1·6 in. . . .	±0·10 in.	21 in.	Over 1-1/8 in. and not exceeding 1-5/8 in.
2·1 in. . . .	±0·10 in.	27 in.	Over 1-5/8 in.

(*ii*) for the tables in clause (*b*) the following tables shall be substituted, namely :—

TABLE

Diameter as cast	Gauge Diameter	Area	Minimum parallel length	Min. radius	Minimum length of plain ends	Screwed ends		Approximate minimum over all length		Main cross-sectional thickness of casting represented
						Size	Min. length	Plain ends	Screwed ends	
B	D	A	P	R	C	E	F	LP	LS	
15·24mm	10·13mm	80·65mm²	25mm	32 mm	32 mm	14 mm dia, 2 mm pitch	14 mm	114 mm	76 mm	Not exceeding 10 mm.
22·125mm	14·32 mm	161·3mm²	51 mm	89 mm	38 mm	19 mm dia, 2·5mmpitch, 22 mm dia, 2·5mm pitch	19 mm	179 mm	122 mm	Over 10 mm and not exceeding 19 mm.
30·48mm	20·27 mm	322·6mm²	51 mm	89 mm	51 mm	29 mm dia, 3mm pitch	29 mm	210 mm	149 mm	Over 19 mm and not exceeding 29 mm.
40·6mm	28·65mm	645·2mm²	51 mm	89 mm	57 mm	38 mm dia, 4mm pitch	38 mm	229 mm	184 mm	Over 29 mm and not exceeding 41 mm.
53·3mm	40·54 mm	1290·4mm²	51 mm	89 mm	83 mm	51 mm dia, 5mm pitch	51 mm	283 mm	210 mm	Over 41 mm.

The test bars shall be cast as parallel bars of the diameter given in column B and then machined to the dimensions D and P in the above table.

Diameter as cast	Gauge Diameter	Area	Minimum parallel length	Min. radius	Minimum length of plain ends	Screw ends		Approximate minimum over all length		Main cross-sectional thickness of casting represented
						Size	Min. length	Plain ends	Screwed ends	
B	D	A	P	R	C	E	F	LP	LS	
0·6 in	0·399in.	0·125 sq. in.	1 in.	1½ in.	1½ in.	9/16 in. dia., 0·083 in & 0·063 in. pitch	9/16 in.	4½ in.	3 in.	Not exceeding ⅝in.
0·875 in.	0·564 in	0·25 sq. in.	2 in.	3½ in.	1½ in.	¾ in. dia., 0·083 in. pitch or ⅞ in. dia, 0·111 in. pitch.	1½ in.	7-1/16 in.	4-13/16 in.	Over 3/8 in. and not exceeding 3/4 in.
1·2 in.	0·798 in.	0·50 sq in.	2 in.	3½ in.	2 in.	1⅞ in. dia., 0·111 in. or 0·143 in. pitch.	1½ in.	8½ in.	5⅞ in.	Over ¾ in. and not exceeding 1⅛ in.
1·6 in.	1·128 in	1·00 sq. in.	2 in.	3½ in.	2½ in.	1½ in. dia., 0·166 in. and 0·125 in. pitch	1½in.	9-1/32 in.	7½ in.	Mover 1-1/8in and not exceeding 1⅜ in.
2·1 in.	1·596 in.	2·00 sq. in.	2·in.	3½ in.	3½ in.	2 in. dia., 0·1429 in. pitch.	2 in.	11⅛ in.	8½ in.	Over 1⅜ in.

The test bars shall be cast as parallel bars of the diameter given in column B and then machined to a dimensions D and P in the above table.

... 51 (2 ... in ... kness a test bar of larger diameter than 53·3 millimeters (2·1 inches) may be used by agreement between the manufacturer and the Inspecting Authority.

(46) For regulation 90, the following regulation shall be substituted, namely:—

90. TRANSVERSE TEST.—A transverse test bar cast in accordance with Regulation 88(a) must, when placed on supports set at a distance shown in column 2 of the following table, sustain a load applied at the centre of not less than that shown in column 3 and must show before rupture a deflection not less than that shown in column 4. The supports and the point of application of the load shall be rounded to a radius of not less than 3 millimeters or (1/8 inch.).

Diameter of test bar	Distance between supports	Minimum breaking load-Grade A	Minimum deflection Grade A
1	2	3	4
15·24mm (0·6 in.)	228·5mm (9 in.)	240 kg (530 lbs.)	1·78mm (0·07 in.)
22·125mm (0·875 in.)	305mm (12 in.)	538 kg (1,185 lbs.)	2·54 mm (0·10 in.)
30·48mm (1·2 in.)	457mm (18 in.)	885 kg (1,950 lbs.)	8·81mm (0·15 in.)
40·6mm (1·6 in.)	457mm (18 in.)	1941 kg (4,280 lbs.)	3·05mm (0·12 in.)
53·3mm (2·1 in.)	610mm (24 in.)	3021 kg (6,660 lbs.)	3·81mm (0·15 in.)

If the diameter of a transverse test bar as cast varies within the limits specified in Regulation 88(a), the equivalent breaking load for the test bar of standard diameter shall be calculated in accordance with the factors given in Appendix F.

(47) For the table below regulation 91, the following table shall be substituted, namely:—

Diameter of test bar	Minimum ultimate tensile stress Grade A
15·24mm (0·6 in.)	19·69 kg/mm² (12·5 tons/sq. in.)
22·125mm (0·875 in.)	18·9 kg/mm² (12·0 tons/sq. in.)
30·48mm (1·2 in.)	17·32 kg/mm² (11·0 tons/sq. in.)
40·6mm (1·6 in.)	16·54 kg/mm² (10·5 tons/sq. in.)
53·3mm (2·1 in.)	15·75 kg/mm² (10·0 tons/sq. in.)

(48) For regulation 92 the following regulation shall be substituted, namely:—

92. NUMBER OF TRANSVERSE AND TENSILE TEST.—The number of tests required for each batch of castings shall be in accordance with the following table, the various classes of castings being divided into four representative groups. One test shall refer to one transverse and one tensile test whether taken from one or two test bars as cast.

Group	Weight of castings	Test requirements
1	Upto 12·7 kilograms (28 lbs.) . .	One test for each 1524 kilograms (30 cwt.) of castings or part thereof.
2	Over 12·7 kilograms (28 lbs. and upto 50·8 kilograms (1 cwt.)	One test for each 2032 kilograms (2 tons) of castings or part thereof.
3	Over 50·8 kilograms (1 cwt) and upto 1016 kilograms or (1 t on)	One test for each 4064 kilograms (4 ton) of castings or part thereof.

In the above Groups 1, 2 and 3, all castings represented by one test must be poured from same ladle or same heat as the bar or bars provided for the test.

4	Over 1016 kilograms (1 ton) and important castings where mutually agreed upon.	One test for each 4064 kilograms (4 tons) of casting or part thereof or for each castings weighing 4064 kilograms (4 tons) or more.

in . . on 94,—

(*i*) in Sub-Regulation (1), for the figures, brackets, letters and words "3/32 inches (12 S.W.G.)", "33 tons per sq. inch" and "3/32 inches", the figures, letters, abbreviations and brackets "2·5 mm (3/32 in.)", "52 kg./mm² (33 tons/sq. in.)" and "2·5 mm (3/32 in.)" shall respectively be substituted;

(*ii*) in sub-Regulation (4), for the figures and words "shall not exceed 18 inches" and "minus 0·002 inch", the words, figures, brackets and abbreviations "shall not exceed 457 mm (18 in.)" and "minus 0·05 mm (0·002 in.)" shall respectively be substituted;

(50) in Regulation 95,—

(*i*) in clause (a), for the figures, letters and words "6 S.W.G.", "26 tons per square inch" and "20 tons per square inch", the figures, abbreviations, brackets and words "5 mm (0·192 in.)", "41 kg/mm² (26 tons/sq. in.)" and "31·5 kg/mm² (20 tons/sq. in.)" shall respectively be substituted;

(*ii*) in clause (c), for the figures and words "28 tons per square inch", the figures, abbreviations, brackets and words "44 kg./mm² (28 tons/sq. in.)" shall be substituted;

(*iii*) in clause (d), for the figures and words "1/8 inch" and "1/16 inch", the figures, abbreviations, brackets and words "3 mm (1/8 inch)" and "1·6 mm (1/16 inch)" shall respectively be substituted;

(*iv*) in clause (e), for the figures, symbols, letters and words "36·5 x W x C tons" the following shall be substituted, namely:—

"C 1 x W x C where C 1 =57·48 kg./mm² or 36·5 tons per square inch";

(*v*) in clause (f), for the figures, letters and abbreviations "6 S.W.G." and "30 ft. lbs." the figures, letters, brackets, abbreviations and words "5 mm (0·2 in.)" and "4·15 kilograms meters (30 ft. lbs.)" shall respectively be substituted;

(51) in Regulation 96,—

(*i*) in sub-regulation (1), for the figure "1/4 inch", the figure, abbreviations and brackets "6 mm (1/4 in.)" shall be substituted;

(*ii*) in sub-Regulation (2), for the figures and words "1/4 inch", "1/8 inch" and "1/16 inch" the figures, abbreviations and brackets "6 mm (1/4 in.)", "3mm (1/8 in.)" and "1·6 mm (1/16 in.)" shall respectively be substituted;

(52) in Regulation 97,—

(*i*) for sub-regulation (1), the following sub-regulation shall be substituted, namely:—

"(*i*) Cruciform—Fillet Weld Tensile Test. Three test specimens one each from test pieces prepared according to the procedures laid down in Appendix H_a, shall be tested in accordance with the method specified therein. If the diameter of the largest size of electrode manufactured is less than 6 mm (1/4 in.) then two specimens only are required. Each specimen shall withstand an ultimate tensile load of not less than C_1 x W x C where C_1=57·48 kg/mm² or

36·5 tons per square inch,

W=the width of the test specimen

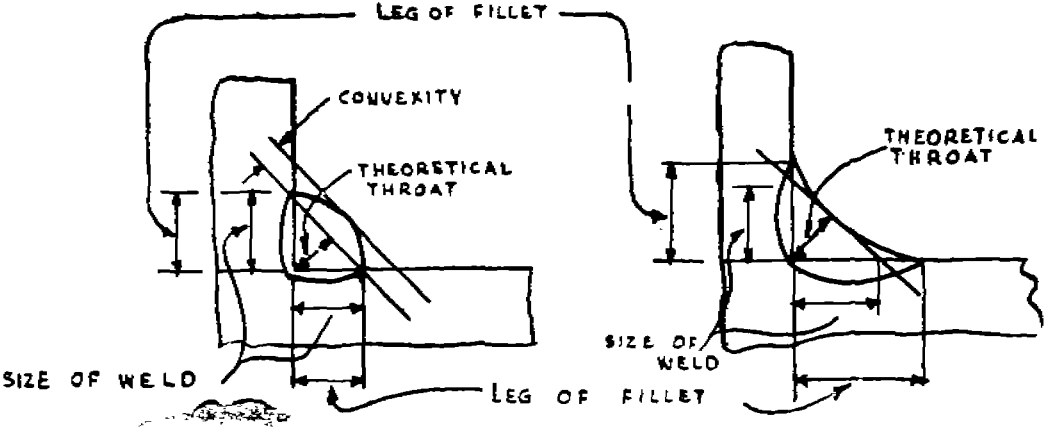
and C =the effective size of welds.

For the purpose of calculating the test load, the effective size of deep penetration fillet welds shall be taken either as 0·7 x [the average length plus 2·5 mm (3/32 in.)] or as the actual mean throat thickness plus 1·6 mm (1/16 in.) whichever is the greater.

(*ii*) in sub-regulation (2),—

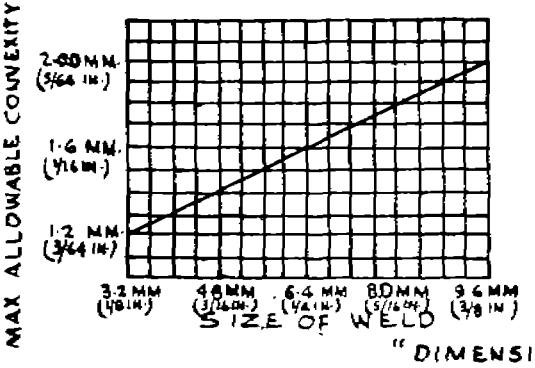
(*a*) in clause (a), for the figures and words "1/16 inch", the figures, abbreviations and brackets "1·6 mm (1/16 in.)" shall be substituted;

(*b*) in clause (b), for the figures and words "3/32 inch", the figures, abbreviations and brackets "2·4 mm (3/32 in.)" shall be substituted;



COVEX FILLET

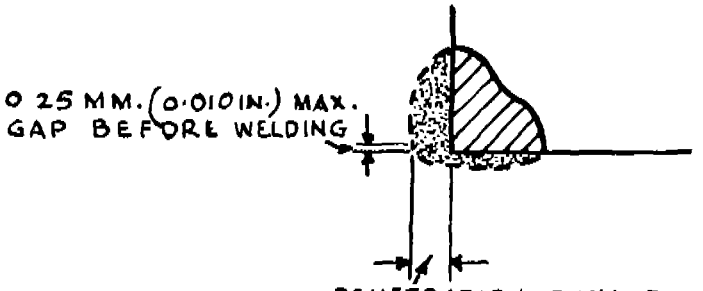
CONCAVE FILLET.



NOTE. 1:- SIZE OF FILLET WELD = LEG LENGTH OF LARGEST INSCRIBED ISOSCELES RIGHT ANGLED TRIANGLE.
NOTE 2:- LENGTH OF HORIZONTAL LEG OF FILLET WELD SHALL NOT VARY MORE THAN 1·6 MM (1/16 IN.) FROM LENGTH OF VERTICAL LEG.
NOTE 3:- FILLET WELD SIZE, CONVEXITY AND LEG LENGTHS OF FILLET WELDS SHALL BE DETERMINED BY ACTUAL MEASUREMENT {TO NEAREST - 0·4 MM (1/64 IN.)} ON A SECTION LAID OUT WITH INSCRIBED LINES AS SHOWN.

"DIMENSIONS OF FILLET WELDS"

FIG 97 (2) (A)



MEASUREMENT OF PENETRATION OF FILLET WELD.
FIG. 97 (2)(B)

(53) In Appendix H-1, (*i*) in clause (1),—for the figures and words—"28 and 32 tons per square inch", the figures and words

"44kg/mm² (28 tons per sq. in.)" and

"50 kg/mm² (32 tons per sq. in.)" shall respectively be substituted.

(*ii*) in clause (2)—

(*a*) for the first paragraph, the following paragraph shall be substituted, namely:

(2) *All-weld Metal Test.—Method of preparation of test pieces:—*

The temperature of the parent metal shall be between 10° and 38°C (50°—100°F) immediately before depositing the first run of weld metal. The test specimen shall not be subjected to any mechanical or thermal treatment other than that required herein. All-weld test pieces shall be prepared as shown in Figure 1* by depositing weld metal between the chamfered edges of two plates, each 22mm (7/8 in.) thick. The preparation of the plates shall give an included angle of 20° and the distance between the plates at the root edges shall be 13mm to 13·5mm(1/2 in. to 17/32 in.) The joint shall be closed at the bottom by a backing plate 32 mm. (1/4 in.) wide by 6mm (1/4 in.) thick. The two plates shall be 178mm (7 in.) long and the dimension B from square edge to root edge of each side plate shall be between:—

51 mm (2 in.) minimum and 76 mm (3 in.) maximum when testing 2·5 mm (3/32 in.) electrodes.

76 mm (3 in.) minimum and 102 mm (4 in.) maximum when testing 3 mm (0·128 in.) or 4mm (0·16 in.) electrodes.

102mm (4 in.) minimum and 127 mm (5 in.) maximum when testing 5 mm (0·2 in.) electrodes.

127 mm (5 in.) minimum and 152 mm (6 in.) maximum when testing 6mm (1/4 in.) or 8 mm (5/16 in.).

The assembly shall be welded together with these plates pre-set so that the gap at the top between the chamfered edges of the plate is 25 mm (1 in.) and the plates may be approximately level when the butt-weld is completed.

(*b*) in the third paragraph, for the figures and words "1/16 inch", "1/8 inch", the figures, abbreviations and brackets "1·6 mm (1/16 in.)" and "3 mm (1/8 in.)" shall respectively be substituted;

(*c*) in the fourth paragraph, for the figures, abbreviations and brackets "1112°F to 1202°F (600° to 650°C)", the figures, words and brackets "600° to 650°C (1112° to 1202°F)" shall be substituted;

(*iii*) in clause (3), for the figures, letters and brackets "50°F (10°C), the figures and letters "10°C (50°F)" shall be substituted;

(*iv*) in clause (4)—

(*a*) in the first paragraph, for the figures, symbols and words "6 inches × 3 inches × ¼ inch" in the two places where they occur, the figures, abbreviations, symbols and brackets "152 mm × 76 mm × 13 mm (6 inches × 3 inches × ¼ inch)" shall be substituted;

(b) in the second paragraph, for the figures, words and brackets "5 in. ", "¼ in.", and "6 S.W.G. (or 0·2 inches)" the figures, abbreviations and brackets " 127 mm (5 in.)", "6mm (¼ in)." and "5 mm (0·2 in.)" shall respectively be substituted;

(*v*) in clause (5),—

(*a*) in paragraph 1, for the figures and words " ¼ inch", " 6 inches" and "¼ inch", the figures, abbreviations, brackets and words "13 mm(½ inch)", and " 127 mm (5 inch)" and "8mm (⅛ inch)" shall respectively be substituted;

(*b*) for Table 1, the following Table shall be substituted, namely:—

TABLE 1

Welding procedure for preparation of transverse tensile test and bend test pieces.

Welding position for test pieces, All Angles 5° as shown in Table-5 below.	Welding procedure
FLAT Weld slope 0° Weld rotation 0°	1. All runs made with 4mm (0·16 in.) electrodes. 2. First run—5mm (0·2 in.) electrodes. Subsequent runs—8mm (5/16in.) diameter electrodes (or largest size manufactured).
INCLINED Weld slope 30° Weld rotation 45°	First run—4mm (0·16 in.) electrodes. Subsequent runs—5mm (0·2in.) electrodes.
HORIZONTAL—VERTICAL Weld slope 0° Weld rotation 90°	First run—4mm (0·16in.) electrodes. Subsequent runs—5mm (0·2 in.) electrodes.
VERTICAL Weld slope 90°	All runs made with 4mm (0·16 in.) electrodes.
OVERHEAD Weld slope 0° Weld rotation 180°	All runs made with 4mm (0·16 in.) electrodes.

(*c*) in the first paragraph after Table 1, for the figures and letters " 8 S.W.G." and "1/8 inch", the figures, abbreviations and brackets " 4 mm (0·16 in.)" and " 3 mm (1/8 in.)" shall respectively be substituted;

(*vi*) in clause (6), for the figures and word " 0·04 inch", the figures, abbreviations and brackets " 1mm (0·04 in.)" shall be substituted :

(*vii*) in clause (7), for the figures and words " 1-1/2 inches" and " 1/20 inches", the figures abbreviations and brackets "38 mm (1 ½in.)" and "1·3 mm (1/20 in.)" shall respectively be substituted;

(*viii*) in clause (8), for the figures, letters and brackets " 50°—100°F (10°-38°C)" the figures, letters and brackets " 10°—30°C (50°—100°F)" shall be substituted;

(*ix*) for Table 2, below clause (8), the following Table shall be substituted;

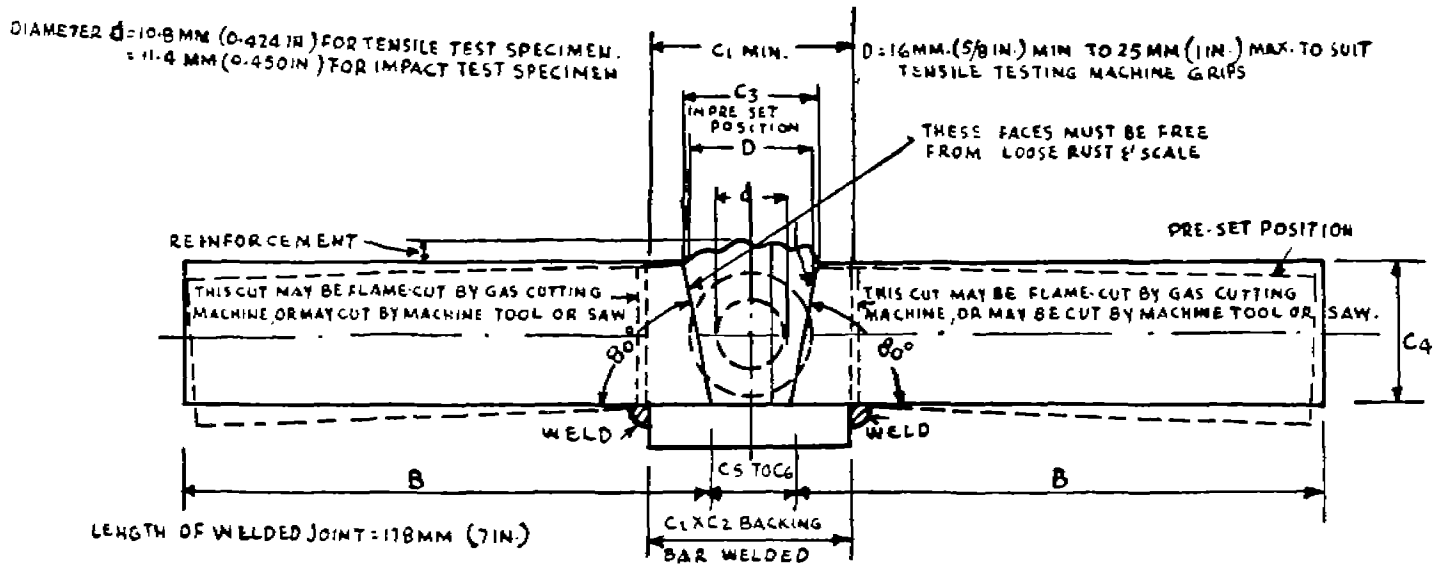
TABLE 2

Welding procedures for preparation of cruciform fillet weld tensile test pieces for normal penetration electrodes.

Welding position for test pieces (All angles (5°) as shown in Table-5 below.	Welding Procedure
FLAT Weld slope 0° Weld rotation 0°	One run—6mm (0·23 in.) or 8 mm 5/16 in.) diameter electrodes.

INCLINED Weld slope 30° Weld rotation 90°	Not more than 3 runs—4mm (0·16 in.) electrodes.
HORIZONTAL—VERTICAL Weld slope 0° . . . . . . Weld rotation 45°	Not more than 3 runs 5mm (0·2 in.) or 6mm (0·23 in.) electrodes.
VERTICAL Weld slope 90°	One run—4mm (0·16 in.) electrodes.
OVERHEAD Weld slope 0° . . . . . . Weld rotation 180°	Not more than 3 runs—4mm (0·16 in. or 5mm (0·2 in.) electrodes.

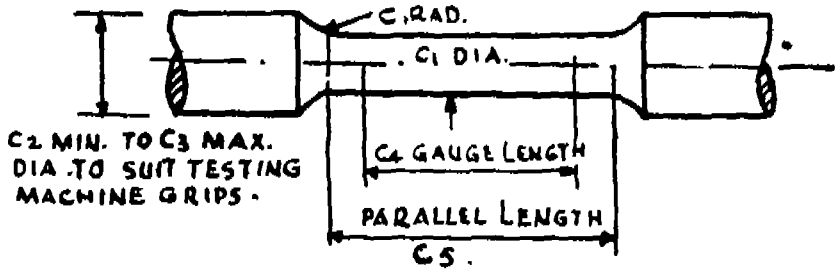
APPENDIX H.1.



METHOD OF PREPARATION OF ALL-WELD-METAL TEST SPECIMEN.

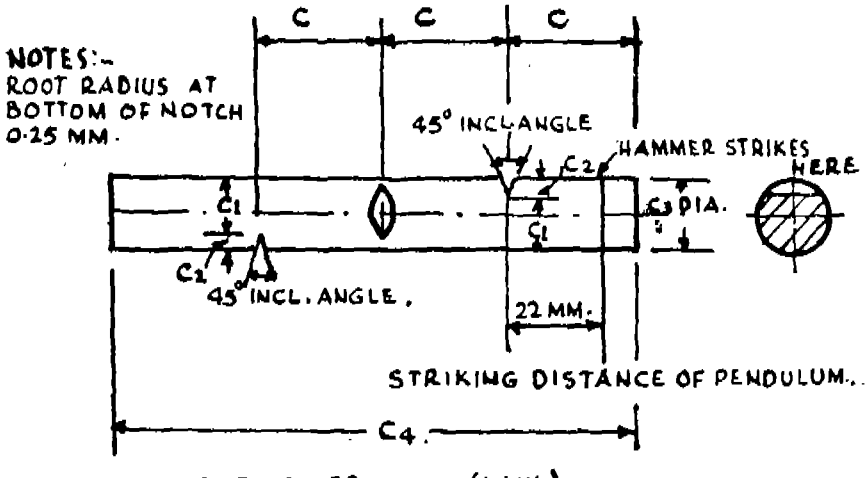
WHERE C = 3MM. (1/8 IN)
C1 = 32 MM (1 1/4 IN.)
C2 = 6 MM (1/4 IN.)
C3 = 25 MM (1 IN.)
C4 = 22 MM (7/8 IN.)
C5 = 13 MM (1/2 IN.)
C6 = 13·5 MM (17/32 IN)

FIG. 1.



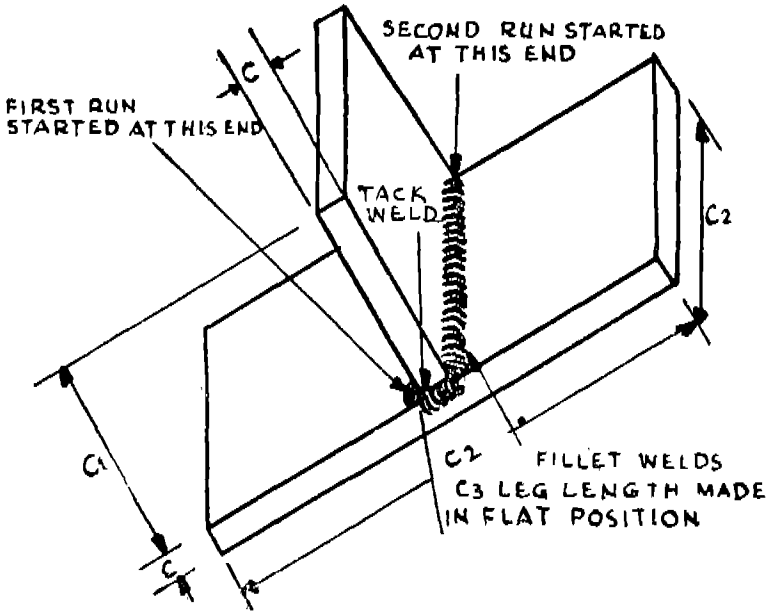
WHERE C = 9·4 MM (0·37 IN)
C1 = 10·8 MM (0·424 IN.)
C2 = 16 MM. (5/8 IN.)
C3 = 25 MM. (1 IN.)
C4 = 88 MM. (1·50 IN.).
C5 = 43 MM. (1·69 IN.).

TENSILE TEST SPECIMEN
FIG. 1(a).



WHERE C = 28 MM. (1·1 IN.).
C1 = 8·4 MM (0·32 IN)
C2 = 3·3 MM (0·13 IN.)
C3 = 11·4 MM. (0·45 IN.)
C4 = 132·04 MM. OR (5·2 IN.)

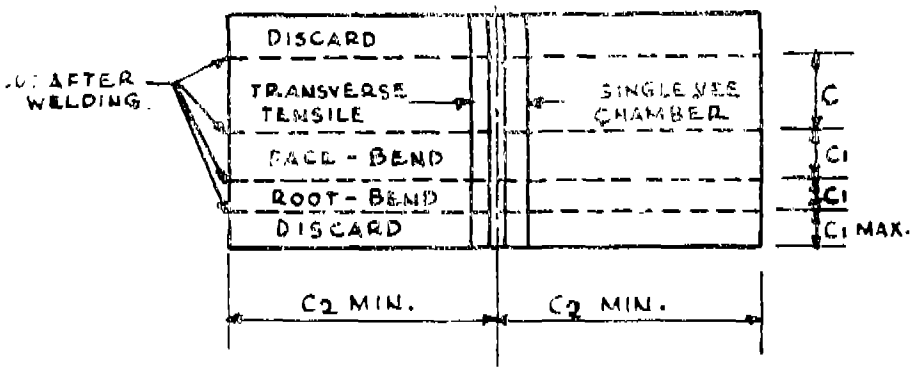
IMPACT TEST SPECIMEN
FIG. 2.



WHERE C = 13MM (1/2 IN.)
C1 = 76 MM. (3 IN.)
C2 = 152 MM (6 IN.)
C3 = 6 MM. (1/4 IN.)

METHOD OF MAKING HOT CRACKING TEST PIECE

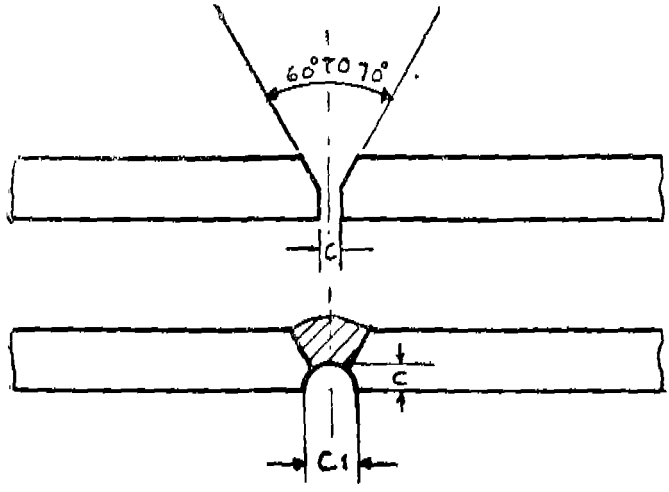
FIG. 3.



WHERE C = 64 MM. (2 1/2 IN.).
C1 = 38 MM. (1 1/2 IN.).
C2 = 152 MM. (6 IN.).

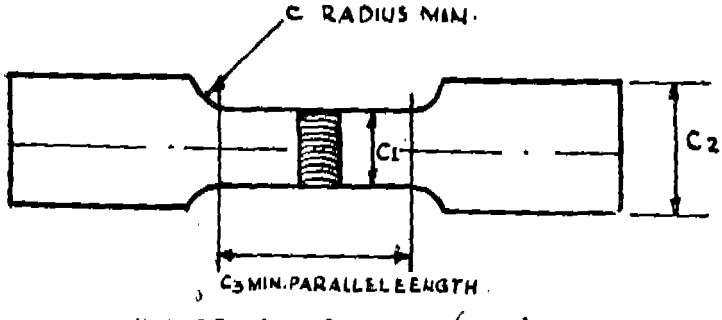
METHOD OF MAKING TRANSVERSE TENSILE & BEND TEST SPECIMENS

FIG. 5



WHERE C = 3MM. (1/8IN.)
C1 = 6 MM (1/4IN.)

GROOVING IN PREPARATION FOR DEPOSITION OF BACKING RUN.
FIG. 5 (a)

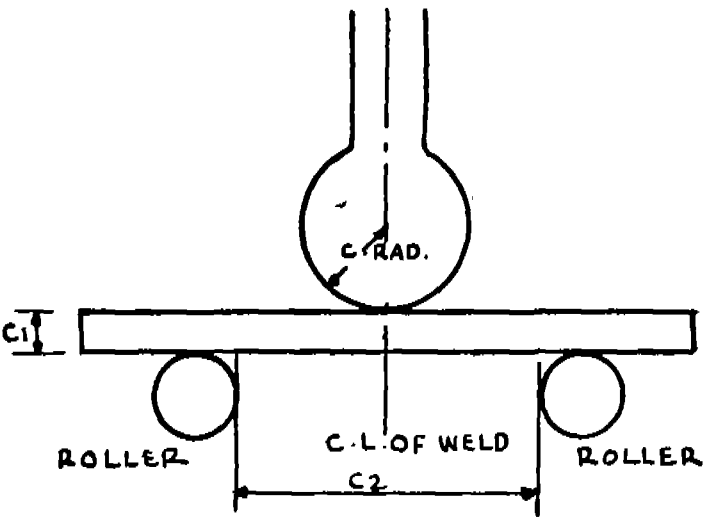


WHERE C = 25 MM. (1IN.)
C1 = 38 MM. (1½IN.)
C2 = 64 MM. (2½ IN.).
C3 = 102 MM. (4 IN.).

DIMENSIONS OF TRANSVERSE TENSILE TEST SPECIMEN

FIG. 6.

NORMAL PENETRATION ELECTRODES.

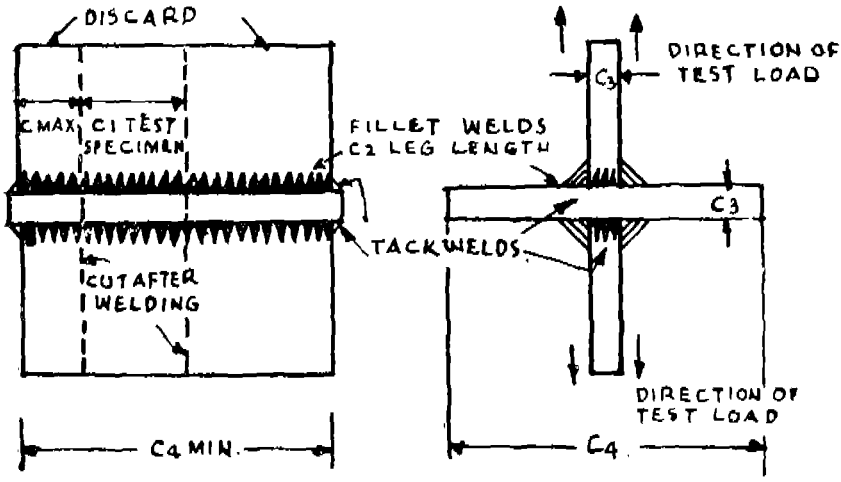


WHERE C = 19MM (3/4IN.)
C1 = 13 MM (1/2 IN.)
C2 = 66 MM (2.6 IN.)

METHOD OF CARRYING OUT BEND TESTS.

FIG. 7

NORMAL PENETRATION ELECTRODES.



WHERE C = 25 MM. (1 IN.)
C_1 = 51 MM. (2 IN.)
C_2 = 10 MM. (3/8 IN.)
C_3 = 16 MM. (5/8 IN.)
C_4 = 152 MM. (6 IN.)

METHOD OF MAKING CRUCIFORM FILLET WELD TEST SPECIMENS.

FIG. 8.

in

(*i*) in the first paragraph, for the figures, letters and brackets " 50°—100°F (10°—38°C)" and " 6 inches", the figures, letters, brackets and abbreviations" 10°—38°C (50° 100°F)" and " 152 mm (6 in.) shall respectively be sustituted;

(*ii*) for Table 3, the following Table shall be substituted, namely:—

TABLE 3

Welding procedure for preparation of butt-weld test pieces. Deep penetration electrodes.

Welding position for test pieces (All angles 5°) as shown in Table 5 below.	Welding procedure.
FLAT Weld slope 0° . . . . . . Weld rotation 0°	1. One run on each side of joints with the largest size of electrode manufactured. Plate thickness equal to twice the deiameter of the core wire or 13mm (½in.), whichever is less. 2. One run on each side of joint with the smallest size of electrode manufactured (but not less than 3 mm or 1/8 in. diameter). Plate thickness equal to at least twice the diameter of the core wire. 3. One run on each side of joint with 6mm (1/4in.) diameter electrodes. Plate thickness not less than 13 mm (½ in.)"

(*iii*) after Table 3, in the first paragraph, for the figures and words " 10 inches" and in the second paragraph for " 0·010 inch", and in the third paragraph " 2 inches" the figures, abbreviations and brackets " 254 mm (10 in.)"," 0·25 mm (0·010 in.)" and " 51 mm (2 in.)" shall respectively be substituted;

(*iv*) in clause (2), for the figures and words " 0·04 inch", the figures, abbreviations and brackets " 1 mm (0·04 in.) shall be substituted;

(*v*) in clause (3), for the figures, words, brackets and letters " 50°—100°F°(10°—38°C)" " 10 inches", " 0·001 inch" and " 2 inches", the figures, abbreviations, brackets and words " 10°—38°C (50°—100°F)", " 254 mm (10 inches)", " 0·25 mm (0· inch" and " 51 mm (2 inches)" shall respectively be substituted;

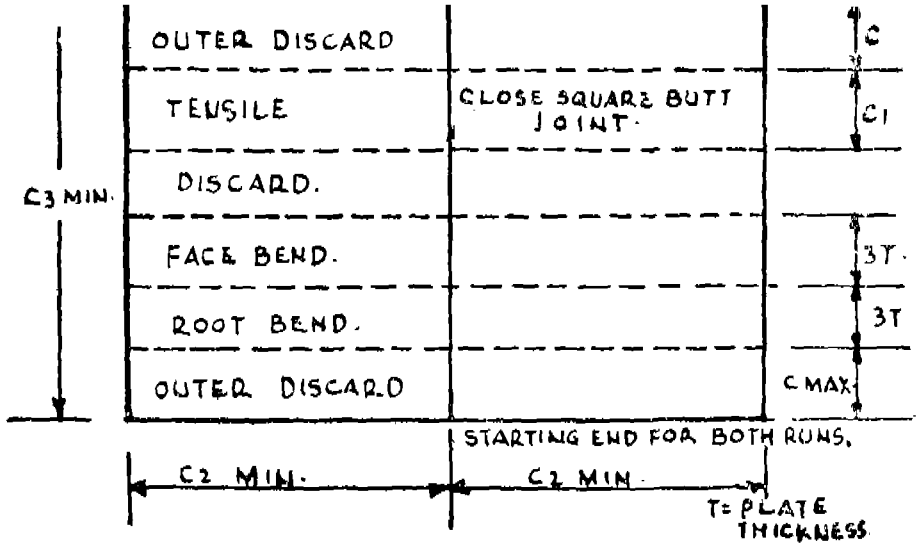
(*vi*) for Table 4, the following Table shall be substituted, namely:—

TABLE 4

Welding procedure for preparation of cruciform fillet weld test pieces (deep penetration electrodes).

Welding position for test pieces (as shown in table 5 below) All angle 45°).	Welding procedure.
HORIZONTAL—VERTICAL Weld slope 0° Weld rotation 45°	1. One run on each side of each joint with the largest size of electrode manufactured. Plate thickness equal to at least twice diameter of the core wire or 13 mm (1/2 in.), whichever is less. Maximum fillet leg length shall be 3mm (1/8 in.) less than the plate thickness. 2. One run on each side of each joint with the smallest size of electrode manufactured, but not less than 3 mm (1/8 in.) diameter. Plate thickness equal to at least twice the diameter, of the core wire. Maximum fillet leg length shall be 3 mm (1/8 inch) less than the plate thickness. 3. One run on each side of each joint with 6 mm (1/4 in.) diameter electrodes. Plate thickness not less than 13 mm (1/2 in.) and fillet lag length not to exceed 10 mm (3/8 in.)

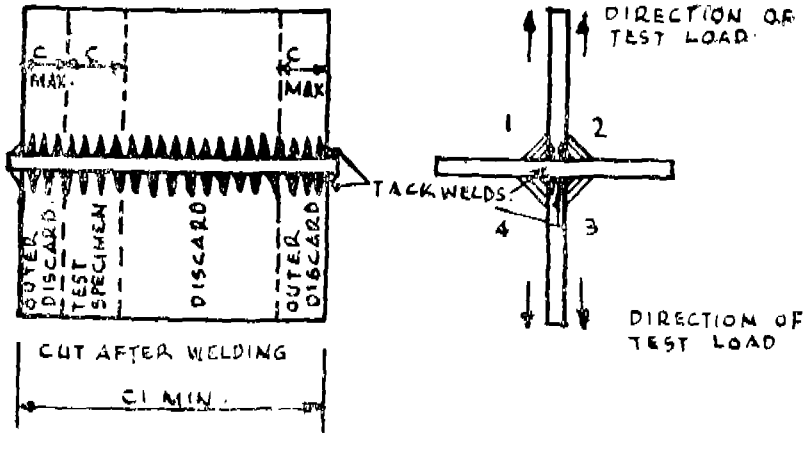
For the Ffgures 9 and 11, the following figures shall be substituted, namely :—



WHERE C = 38 MM. (1½ IN.)
C1 = 64 MM. (2½ IN.)
C2 = 152 MM (6 IN.)
C3 = 254 MM. (10 IN.)

METHOD OF MAKING BUTT WELD TEST SPECIMENS.

FIG. 9



WHERE C = 51 MM. (2 IN.)
C1 = 254 MM (10 IN.)

METHOD OF MAKING CRUCIFORM FILLET WELD TEST SPECIMENS

FIG. 11

(55) in Regulation 101, for the figures and words "¼ inch", the figures, words and brackets "6 millimeter (¼ inch)" shall be substituted;

(56) for Regulations 104 and 106, the following Regulations shall respectively be substituted namely:—

(57) For regulation 104, the following regulation shall be substituted, namely:—

104. *Circumferential and End Seams.*The calculated efficiencies of circumferential joints based on the thickness of plate determined by Equation 1 shall be not less than 38 percent for joints connecting and plates with cylindrical shells, or 42 percent for intermediate joints. In no case, however, shall the efficiency of an intermediate joint be less than 50 per cent of that of the longitudinal joints. Where the shall plate thickness exceeds 18 millimeter (11/16in.) the intermediate circumferential joints shall be double riveted.

(58) For regulation 106, the following regulation shall be substituted namely:—

106. *Thickness of shell Angle Rings.*—Where shell plates and end plates are connected by means of an external angle ring, the angle rings shall be not less in thickness than as follows:—

(1) For shell plates upto and including 16 mm (5/18 in.) in thickness.	10 per cent in excess of the thickness of the shell plate.
(2) For shell plates exceeding 16mm in thickness and upto and including 25 mm (1 in.) in thickness.	90 per cent of the thickness but not less than 18 mm (11/16 in.).
(3) For shell plates over 25 mm (1 in.) in thickness	Made from angle bar having a section thickness of 25 mm.

(59) for clauses (b) and (d) of Regulation 107, the following clauses shall be substituted, namely:—

(*b*) For small steam domes not exceeding 381 millimeters (15 inches) diameter when the welding is done by hammer and the plates do not exceed 13 millimeters (1/2 inch) thickness, butt straps may be omitted.

(*d*) As an alternative to riveting, shell boilers not exceeding 1371 millimeters (4 ft. 6 in.) in diameter and the maximum working pressure of 8·4 kg/cm². (120 lb/sq. in.) may be fabricated by fushion welding provided the longitudinal, circumferential and endseams comply with conditions laid down in Regulations 247 to 269.

The working pressure of such shells shall comply with Regulation 176, where J=100 and C=2·75.

(60) For regulation 108, the following regulation shall be substituted, namely:—

108. *Longitudinal seams.*—The longitudinal seams of shell belts shall be butt-joined with double straps when the diameter or working pressure exceeds the limit stated below:

Type of Boiler . .	When diameter exceeds	When working Pressure exceeds.
Loco Types . . .	762 mm (2 1/2 feet)	14·0 kg/cm². (200 lbs/sq. in.)
Vertical Types . .	1829 mm (6 feet)	8·8 kg/cm² (125 lbs/sq. in.)
Other types . . .	1829 mm (6 feet)	5·6 kg/cm² (80 lbs./sq. in.)

(61) in Regulation 114,—

(i) for clause (a), the following clause shall be substituted, namely :—

114. **Strengthening of Flat End plate at Manhole.**—(a) In the End plates of Lancashire Boiler type the mudhole in the lower part of the front end plate shall be fitted with a flanged riveted strengthening ring, the thickness of the flat portion of which shall be not less than (1·5T+C) where Tequals the thickness of the end plate in millimeters (inches) and C equals 3 millimeters (1/8 inch.)

(ii) in clause (b), for the figures and abbreviations "7 ft. 6 in.", the figures, abreviations and brackets "2286 mm (7 ft. 6 in.) shall be substituted ;

(iii) in clause (d) for the figures and abbreviation "1½ in.", the figures, brackets and abbrviations "38 mm (1½ in.)" shall be substituted ;

(62) in Regulation 117,—

(i) in clause (b), for the figures and word "2½ inches", the figures, abbreviations and brackets "64 mm (2½ in.) " shall be substituted ;

(ii) in clause (c), for the figures and word "1 inch", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted ;

(63) in Regualtion 119, for the figure and abbreviations "7 sq. ft. and 21sq. ft." the figures, words, brackets and abbreviations "6503 square centimeter (7 sq. ft.)" and 19509 square centimeter (21 sq. ft.) shall be substituted ;

(64) in Regulation 121, for the figures and word "7/8 inch", the figures, abbreviation, brackets and word "22 mm (7/8 inch)" shall be subsituted ;

(65) in Regulation 122,—

(i) in clause (c), for the figure and word "12 inches", the figures, words and brackets "305 millimeters (12 inches)" shall be substituted ;

(ii) in clause (g), for the figure and word "6 inches", the figures, abbreviations and brackets "152 mm (6 in.)" shall be substituted ;

(iii) for sub-clause (i), the following sub-clause shall be substituted, namely :—

"(i) Where the flues are flanged for attachment to the end plates, the end section shall be 1·6 mm (1/16 inch) thicker than the remaining sections, except in cases where the calculated thickness is over 20·6 mm (13/16 inch), when the end section shall be 22 mm (7/8 inch) in thickness.";

(iv) in cluase (j), for the figure and word "1 inch" the figures abbreviations and brackets "25 mm (1 in.)" shall be substituted ;

(v) in clause (1), for the figures and symbols "2½" + ½", the figures, abbreviations and symbols "64 mm + 13 mm (2½" +½")" shall be substituted ;

(66) For clause (b) for regulation 123, the following clause shall be substituted, namely :—

(b) Circular furnances shall preferably be tapered, a taper of 38 mm (1½ inch) in diameter per 305 mm (1 foot) of height being recommended. The minimum water space at the bottom between the furnances and the shell shall not be less than 51mm (2 inches) for boilers upto 762 mm (2 ft. 6 in.) in diameter and shall be not less than 64 mm (2½ in.) for boilers over 762 mm (2 ft. 6 in.) in diameter.

(67) In Regulation 124, for the figures and symbol "3/8"" the figures, abbreviations and brackets "10 mm (3/8 in.)" shall be substituted ;

(68) in clause (a) of Regulation 125, the following clause shll be substituted, namely :—

(a) Plates over 16 millimeters (5/8 in.) in thickness shall be bevelled from both sides of each abutting edge, but the bevel need not necessarily be the same on each side (see Figs. 1 & 2). Plates less than 16 mm (5/8 in.) in thickness say be bevelled from one side only of each abutting edge (see Figs. 3 & 4).

The included angle of the bevel shall be not less than 60°, and the bevelling may be any one of the forms shown in Figs. 1—4.

(68) In clause (b) of Regulation 126, for the figures and words "1½ inches", the figures abbreviations and brackets "33 mm (1½ in.)" shall be substituted ;

(69) in Regulation 127,—

(i) for clause (b), the following clause shall be substituted, namely :—

"(b) Cross tubes shall not exceed 305 mm (12 in.) in internal diameter. The minimum thickness shall be 8 mm (5/16 in.)" ;

(ii) in clause (d), for the figures and abbreviation "5/8 in.", the figures, abbreviations and brackets "1·6 mm (5/8 in.)" shall be substituted ;

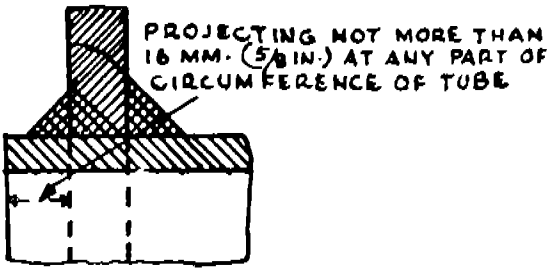


FIG. 5.

(70) in Regulation 128, in clause (b), for the figure and word "1 inch", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted ;

(71) in Regulation 129-A,—

(i) For the table in figure 5A, the following table shall be substituted, namely:—

(1) for the table in Fig. 5A, the following table shall be substituted, namely —

NOMINAL THICKNESS OF TEST PIECE,	(i)	(ii)	(iii)	(iv)
	UPTO BUT NOT INCLUDING 10 MM. (3/8 IN.).			10 MM. (3/8 IN.) AND THICKER.
WIDTH ..... W.	13 MM. (½ IN.)	25 MM. (1 IN.)	38 MM. (1½ IN.)	38 MM. (1½ IN.)
GAUGE LENGTH ... G.	51 MM. (2 IN.)	102 MM. (4 IN.)	203 MM. (8 IN.)	203 MM. (8 IN.)
PARALLEL LENGTH MIN. ... P.	64 MM. (2½ IN.)	114 MM. (4½ IN.)	229 MM. (9 IN.)	229 MM. (9 IN.)
RADIUS AT SHOULDER .. R	25 MM. (1 IN.)	25 MM. (1 IN.)	25 MM. (1 IN.)	25 MM. (1 IN.)
APPROX. TOTAL. LENGTH.	203 MM. (8 IN.)	305 MM. (12 IN.)	457 MM. (18 IN.)	457 MM. (18 IN.)

FIG. 5.A.

(ii) for the Second para of sub-clause (iv), the following sub-clause shall be substituted namely ;—

"Each of the three text pieces shall be tested and shall show a tensile strength not less than 14.17 kg/mm² (9 tons/sq. in.) for plates upto and including 13 mm (½ in.) in thickness and not less than 12·6 kg/mm² (8 tons/sq. in.) for plates over 13mm (6 in.) upto and including 25mm (1 in.) in thickness.

(iii) in sub-clause (v), for the figures and abbreviations '6 in.' and '15 ft.' the figures, abbreviations and brackets '152 mm (6 in.)' and '4·5 meters (16 ft.)' shall respectively; be substituted ;

(72) in Regulation 131, for the figures, word and abbreviation '12 feet' and '6 ft", the figures words and brackets '3·6 meters (12 feet)' and '1·8 meters (6 feet)' shall respectively be substituted

(73) in Regulation 132, for the figures and abbreviations '¼ in. the figures, abbreviations and brackets '6 mm (¼in.)' shall be substituted ;

(74) for Regulation 133, the following Regulation shall be substituted, namely :—

133. *Jointed stays.*—Where jointed longitudinal stays are fitted, they shall, where practicable, be fitted with pins having an effective sectional area 25 percent in excess of that of the stay. If the pins are slack in the holes, the total slackness shall not be more than 1·6 mm (1/16 in.). The pins shall be as close as possible to the shoulder of the eye forging. The shoulder of the forging shall be at least 13mm (½ in.) wide all round, i.e. the diameter at the shoulder shall be not less than the diameter of the hole plus 25mm (1. in.)

(75) For clauses (c), (d) & (f) of regulation 135, the following clauses shall be substituted, namely :—

(c) The stays shall be screwed with fine threads of pitch not more than 2·5mm (not less than 11 threads per inch).

(d) The diameter of the stay over the threads shall not be less than 19 mm (¾ in.) or twice the thickness of the firebox plate whichever is the greater.

(f) Where the stays are not fitted with nuts, the ends shall be riveted over to form substantial heads.

Alternatively stays may be screwed through the shell and firebox plates and the projecting ends shall be substantially fillet-welded in an approved manner. The projection of the end of the stay from the surface of the plate shall be not less than one quarter of the diameter of the stay but in no case less than 6mm (¼in.). The full end of the stay shall be visible on completion of the welding.

(76) For regulation 136. the following regulation shall be substituted, namely :—

136. *Axial drilling* .—All screwed stays less than 356 mm (14 in.) long should preferably be drilled with a tell-tale hole 5mm (3/16 in.) diameter to a depth of 13mm (½ in.) beyond the inner face of the plate. Stays which are obscure on one side should preferably be made from hollow stay bar.

(77) For clause (a) of regulation 137, the following clause shall be substituted, namely :—

137. *Stay nuts.*—(a) Nuts to screw stays in combustion chambers and fire boxes shall not be less than 19mm (¾in.) thick for stays upto 38 mm (1½ in.) diameter over threads, 22mm (7/8 in.) thick for 41 mm (15/8 in.) and 44mm (1¾ in.) stays, 25mm (1 in.) thick for 48 mm (1-7/8 in.) and 51mm (2 in.) stays, and 29mm (1-1/8 in.) thick fot stays over 51 mm (2 in.) in diameter.

(78) For clause (b) of regulation 139, the following clause shall be substituted, namely :—

(b) The clear water-way between the crown plate and the underside of the girder bars shall be as large as practicable but in no case less than 38mm (1½ in.) as in fig. 7.

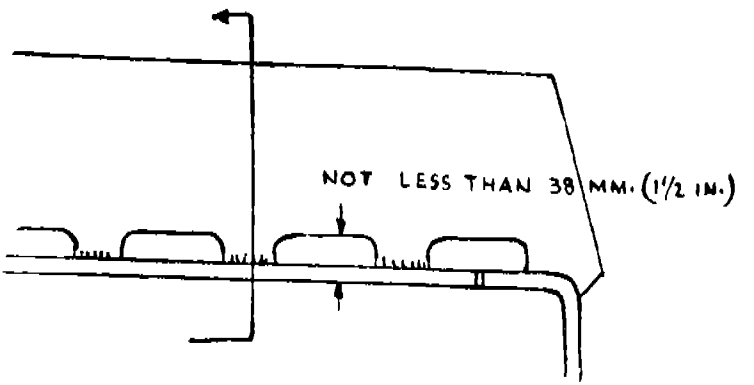


FIG. 7.

(79) in Regulation 141,—

(i) for the table below clause (b), the following table shall be substituted, namely :—

Thickness of end plates	L (Fig. 8)	L (Fig. 9)
13 mm (½ in.)	228·5 mm (9 in.)	254 mm (10 in.)
14·5 mm (9/16 in.)	254 mm (10 in.)	279 mm (11 in.)
16 mm (5/8 in.)	279 mm (11 in.)	305 mm (12 in.)
17·5 mm (11/16 in.) 19 mm (¾ in.) 20·5 mm (13/16 in.)	305 mm (12 in.)	330 mm (13 in.)
Above 20·5 mm (13/16 in.)	318 mm (12½ in.)	343 mm (13½ in.)

(ii) in clause (d), for the figure and abbreviation "1 in.", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted ;

(iii) in clause (e), for the figures, word and abbreviation '6 ft.' and "1½ inch", the figures, words, brackets and abbreviations "1·8 meters (6 ft.)" and "38 mm (1½ in.)" shall respectively be substituted ;

(iv) in cluase (g), for the figures and word "8 inch", the figures, abbreviations and brackets "203 mm (8 in.)" shall be substituted ;

(80) in Regulation 142, for the figures and abbreviations "½ in." the figures, abbreviations and brackets "13 mm (½ in.)" shall be substituted ;

(81) in Regulation 146, in clause (b), for the figures and word '¼ inch', the figures, abbreviations and brackets "6 mm (¼ in.)" shall be substituted ;

(82) in Regulation 147, for the clause (a), the following clause shall be substituted, namely :—

(i) 147. **Screw Threads of stay tubes** .—(a) Stay tubes shall be screwed at both ends with continuous threads and the holes in the tube plates shall be tapped with continuous threads. The pitch of threads shall not be less than 2·5 mm (not finer than 11 threads per inch.) The stay tubes shall be expanded by roller expanders and not made tight by caulking only.

(ii) (b).—For the Figures 9A in clause (b) of regulation 147, the following figure shall be substituted namely :—

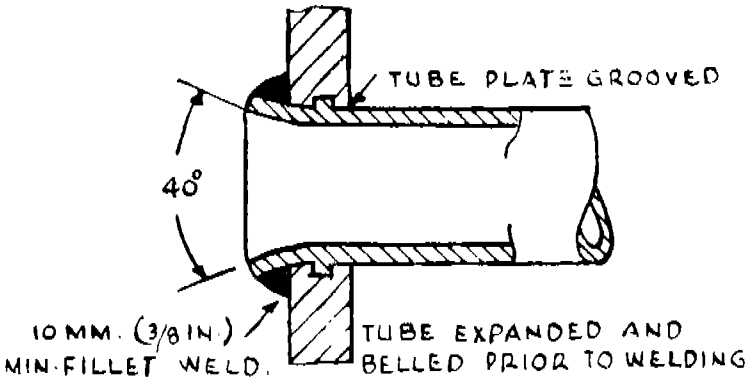


FIG. 9.A.

(83) in Regulation 151, for clause, (*b*) the following clause shall be substituted, namely :—

(*b*) Tubes having an external diameter not exceeding 127 mm (5 in.) may be jointed and such joints may be flash welded, machine forge welded, arc or gas welded. Tubes above 127 mm (5 in.) diameter may also be welded provided they are located outside the furnace. Such welds must be conform to the requirements of Chapter VIII.

(84) in Regulation 152,—

(*i*) in clause (*b*), for the figures and abbreviation "1/4 in." and "1/16 in.", the figures, abbreviations and brackets "6 mm (1/4 in.)" and "1·6 mm (1/16 in.)" shall respectively be substituted ;

(*ii*) in clause (*d*), for the figures and word "½ inch", the figures, abbreviations and brackets "13 mm (½ in.)", shall be substituted :—

(85) for Regulation 153, the following Regulation shall be substituted, namely;

153. *Copper tubes.* Copper tubes upto 25 mm (1 inch) in external diameter my used for small boilers, such tubes shall not be less than 2·6 mm (0·104 in.) thick.

(86) For Regulation 156, the following regulation shall be substituted, namely :—

156. (*a*) *Design of stand Pipes.*—Where short stand pipes are used, the bolting flanges shall be forged solid with bodies or attached by combined screwing and welding or by welding alone. Solid forged stand pipes shall have a minimum thickness of flange and of body in accordance with the table below :—

	Maximum permissible working pressures							
	Upto 10·5 kg/cm² (150 lbs/sq. in.)		Above 10·5 kg/cm² & upto 17·5 cm² (250 lbs/sq. in.)		Above 17·5 kg/cm² & upto 24·5 kg/cm² (350 lbs/sq. in.)		Above 24·5 kg/cm² and upto 42·0 kg/cm² (600 lbs/sq. in.)	
	Flange adjoining drum	Body	Flange adjoining drum	Body	Flange adjoining drum	Body	Flange adjoining drum	Body
Stand pipes bore								
19mm (3/4 in.) .	..	..	..	..	..	..	19mm (3/4 in.)	10mm (3/8 in.)
25mm (1 in.) .	11mm (7/16 in.)	10mm (3/8 in.)	13mm (½ in.)	10mm (3/8 in.)	19mm (3/4 in.)	10mm (3/8 in.)	19mm (3/4 in.)	10mm (3/8 in.)
32mm (1-1/4 in.) .	11mm (7/16 in.)	10mm (3/8 in.)	13mm (½ in.)	10mm (3/8 in.)	19mm (3/4 in.)	10mm (3/8 in.)	19mm (3/4 in.)	10mm (3/8 in.)
38mm (1½ in.) .	11mm (7/16 in.)	10mm (3/8 in.)	13mm (½ in.)	11 mm (7/16 in.)	19mm (3/4 in.)	13mm (½ in.)	19mm (3/4 in.)	13mm (½ in.)
51 mm (2 in.) .	11mm (7/16 in.)	10mm (3/8 in.)	14·5mm (9/16 in.)	11mm (7/16 in.)	19mm (3/4 in.)	13mm (½ in.)	22mm (7/8 in.)	13mm (½ in.)
64mm (2½ in.) .	11mm (7/16 in.)	10mm (3/8 in.)	14·5 mm (9/16 in.)	11mm 7/16 in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
76mm (3 in.) .	14·5 mm (9/16 in.)	11mm (7/16 in.)	16mm (5/8 in.)	13 mm (½ in.)	22mm (7/8 in.)	16 mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
89mm (3½ in.) .	14·5mm (9/16 in.)	11mm (7/16 in.)	16mm (5/8 in.)	13mm (½ in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
102mm (4 in.) .	14·5mm (9/16 in.)	11mm (7/16 in.)	16mm (5/8 in.)	13mm (½ in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
114mm (4½ in.) .	14·5mm (9/16 in.)	11mm (7/16 in.)	16mm (5/8 in.)	13mm (½ in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
127mm (5 in.)	16mm (5/8 in.)	14·5mm (9/16 in.)	19mm (3/4 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
152mm (6 in.) .	16mm (5/8 in.)	14·5mm (9/16 in.)	19mm (3/4 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
178mm (7 in.) .	16mm (5/8 in.)	14·5mm (9/16 in.)	19mm (3/4 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)
203mm (8 in.) .	16 mm (5/8 in.)	14·5mm (9/16 in.)	19mm (3/4 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16mm (5/8 in.)	22mm (7/8 in.)	16 mm (5/8 in.)

229 mm (9 in.)	16 mm (5/8 in.)	16 mm (5/8 in.)	19 mm (3/4 in.)	16 mm (5/8 in.)	22 mm (7/8 in.)	16 mm (5/8 in.)	..
254 mm(10 in.)	16 mm 5/8 in.)	16 mm (5/8 in.)	19 mm (3/4 in.)	16 mm (5/8 in.)	22mm (7/8 in.)	..	..
Pressed saddles	16 mm (5/8 in.)	..	19mm (3/4 in.)	..	22 mm (7/8 in.)	..	..

(*b*) The thickness of Stand Pipes and Branches secured to drums and headers by expanding screwing or welding shall be not less than that given in table below :—

Minimum Body thickness of standpipes and Branches secured by expanding screwing or welding

Nominal Bore of Stand pipes and Branches	Thickness of shell	Minimum body thickness
Upto and including 38 mm (1½ in)	13 mm (½ in.) and over	6 mm (1/4 in.)
Over 38 mm (1½ in.) upto and including 64mm (2½ in.)	16 mm (5/8 in.) and over	8 mm (5/16 in.)
Over 64 mm (2½ in.) upto and including 114 mm (4½ in.)	22mm (7/8 in.) and over	11 mm (7/16 in.)
Over 114 mm. (4½ in.) upto and including 203 mm (8 in.)	25 mm (1 in.) and over	13 mm (½ in.)
Over 203 mm (8 in. upto and including 254 mm (10 in.)	32 mm (1¼ in.) and over	16 mm (5/8 in.)

*For thinner shells than given above, minimum body thickness not less than one-half the thickness of the shell.

(87) For Regulation 158, the following regulation shall be substituted, namely:—

158. *Seating for Mountings.*—For pressures not exceeding 8·8 kg/cm² (125 lbs/sq. in) mountings with screwed ends not exceeding 25mm bore and threads of pitch 2·5 mm (1 in. bore and 11 threads per inch), may be used ; the screwed portion of any such mounting being an integral part thereof and the thickness at the bottom of the thread being not less than 5mm (3/16 in.).

The mountings may be screwed :—

(*a*) Directly into the boiler shell plate, nuts being fitted on the waterside.

OR

(*b*) Into steel distance pieces the length of thread engaged being in no case less than the bore of the mounting plus 6 mm (1/4 in.).

(88) In Regulation 160, in clause (*b*),—

(*i*) for the figures and words "1 inch" in the two places where they occur and "2 inches" in the two places where they occur, the figures, abbreviations, brackets and words " 25 mm (1 inch)" and " 51 mm (2 inches)" shall respectively be substituted;

for sub-clauses (i) and (*iii*) of paragraph 2, the following sub-clauses shall be substituted —

(*i*) Where stand pipes are screwed, the screwing shall be to any of the national Standard Pipe Thread.

(*iii*) Where the bore of the stand pipe or seating and the hole in the plate does not exceed 127 mm. (5 in.) plus twice the thickness of the plate, the seating may be welded the plate without subsequent heat treatment of the weld so made. Where the hole in the plate exceeds 127 mm (5 in.) plus twice the thickness of the plate, the plate to which the seating is attached shall be stress relieved by heat treatment.

(89) In Regulation 164,—

(*i*) in clause (*a*), for the figures, abbreviations and symbol, " 3½in. × 2½ in" the figures, abbreviatons, brackets and symbol " 89 mm × 64 mm (2½in. ×2½in.)" shall be subs tituted ;

(*ii*) for the table under clause (*b*), the following table shall be substituted, namely :—

Boiler not exceedig 762 mm (2 ft. 6 in.)	229 mm × 178mm (9in. × 7 in.)
Boilers over 762 mm diameter and not exceeding 914 mm (3 ft.)	305 mm × 229 mm (12 in. × 9 in.)
Boilers over 914 mm diameter and not exceeding 1067 mm (3 ft. 6 in.)	356 mm × 254 mm (14 in. × 10 in.)
Boilers over 1067 mm diameter and not exceeding 1219 mm (4 ft.)	381 mm × 279 mm (510 in. × 11 in.)
Boilers over 1219 mm (4 ft.)	406 mm × 305 (16 in. × 12 in.)

(*iii*) in clause (d), for the figure and abbreviation "3 ft.", the figures, abbreviations, brackets "914 mm (3 ft.)" shall be substituted.

(90) In Regulation 165,—

(*i*) in clause (a), for the figures and abbreviation "9/16 in.", the figures, abbreviations and brackets "14·5 mm (9/16 in.)" shall be substituted.

(*ii*) in clause (b), for the figures, abbreviations and symbol "12 in. × 9 in.", the figures abbreviations, symbols and brackets "305 mm×229 mm (12 in. × 9 in.)" shall be substituted ;

(91) In Regulation 166,—

(*i*) in clause (a), for the figures, letters and words "1/16th inch" and "1/8th inch", the figures, abbreviations and brackets "1·6 mm (1/16 in.)" and "3 mm (1/8in.)" shall respectively be substituted ;

(*ii*) in clause (b), for the figures, abbreviations and words "200 lbs. per square inch", the figures, abbreviations, brackets and words "14 Kg/Cm^2 (200 lb. per square inch)" shall be substituted ;

(*iii*) in clause (c), for the figures, abbreviations and symbols "9 in. × 7 in." and "5 in. × 3½ in.", the figures, abbreviations, symbols and brackets "229 mm × 178 mm (9 in. ×7 in.)" and "127 mm × 89 mm (5 in. ×3½ in.)" shall respectively be substituted.

(92) For clause (a) of Regulation 167, the following clause shall be substituted :—

167. *Raised manhole frames and cover plates.*—(a) Raised circular manhole frames not exceeding 406 mm (16 in.) in diameter shall be at least 19mm (¾ in.) thick in all parts. The circular cover plates and joint flanges for such frames shall be not less than :—

25mm (1 in.) thick for pressures not exceeding 8·4 kg/cm^2 (120 lbs/sq. in.)

29mm (1¼ in.) thick for pressures over 8·4 kg/cm^2 (120 lbs/sq. in.) but not exceeding 14 kg/cm^2 (200 lbs/sq. in.)

32mm (1¼in.) thick for pressures over 14 kg/cm^2 (200 lbs/sq. in.) but not exceeding 17·5 kg/cm^2 (250 lbs/sq. in.)

For pressures 17·5 kg/cm^2 (250 lbs/sq. in.) and over raised circular manhole frames shall not be fitted.

The cover plates shall be secured by at least sixteen steel bolts not less than 25 mm (1 in.) diameter.

(93) in Regulation 170,—

(*i*) for clause (a), the following clause shall be substituted, namely :—

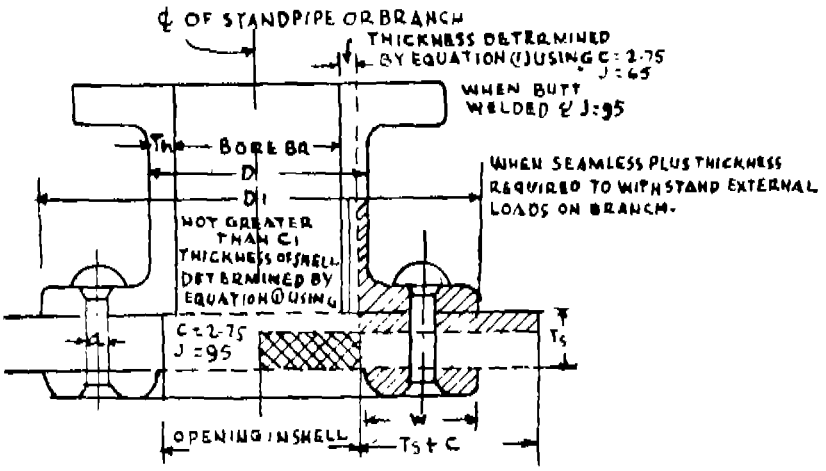
(*a*) Where holes are cut in the cylindrical shell for the purpose of attaching a seating, frame or door, compensation shall be provided such that the added sectional area including parts of the frame within 102 mm (4 in.) of the shell and excluding river holes, shall be not less than the sectional area of the plate removed which shall be the product of the diameter of the opening and the calculated thickness of the plate as found by Equation 1. Where holes are cut in the cylindrical shell for the purpose of fixing seating for mountings and the diameter of the holes is greater than 2·5 times the thickness of the shell plate plus 70 mm (2¾ in.), compensation shall be provided. Where large opening is cut in a cylindrical shell to receive another part of the structure, the sides where cut away shall be efficiently cross stayed or strengthened in some other effective manner.

(*ii*) For sub-clause (ii) of clause (b), the following sub-clause shall be substituted, namely:—

(*ii*) The area obtained by multiplying the difference between the actual shell thickness and the calculated thickness, by a length 2(C+TS—d)

Where C = 76mm or 3 inches
Ts = Thickness of shell plate
d = diameter of rivet holes

In cases where the sum of (i) and (ii) is less than the sectional area to be compensated, a compensating plate shall be fitted having the net cross sectional area equal to the amount of the deficit



WHERE C = 76 MM. (3 IN.)
C1 = 102 MM. (4 IN.)

NOTE :- AREA Y ▨ TO BE NOT LESS THAN AREA X ▩

COMPENSATION FOR RIVETED STAND PIPES
AREA TO BE COMPENSATED AND CORRESPONDING
AREA ALLOWABLE FOR COMPENSATION.

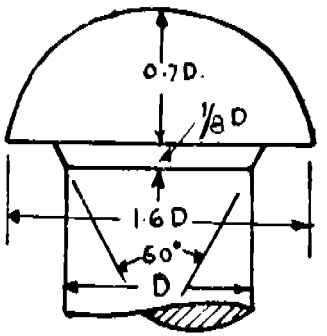
FIG. 25A.

(94) in clause (b) of Regulation 171, for the figures and word "8 inches," the figures, abbreviations, brackets and word "203 mm (8 inches)" shall be substituted ;

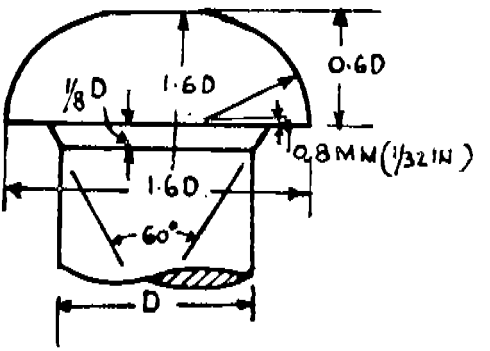
(104) in the Appendix H-4 for the sketches the following sketches shall be substituted namely :—

APPENDIX - H-4 - SKETCH - 1

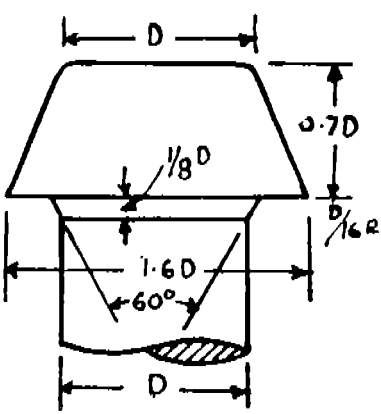
HEADS FOR BOILER RIVETS.



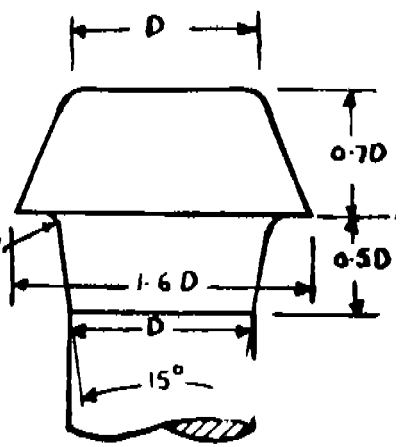
SNAP HEAD



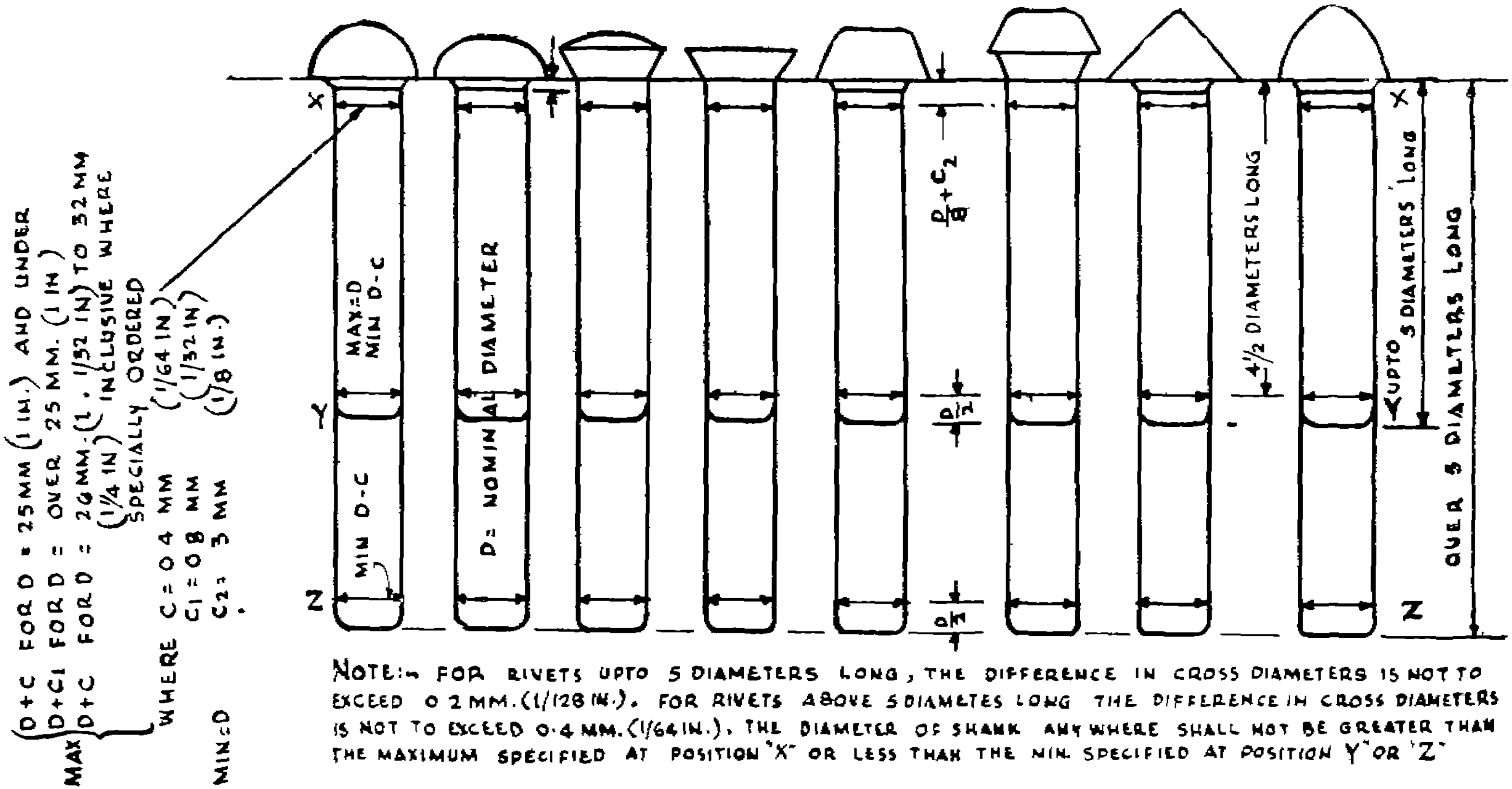
ELLIPSOIDAL HEAD



PAN HEAD



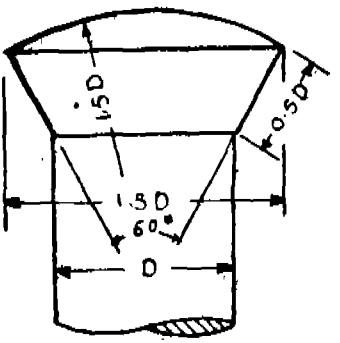
PAN HEAD WITH TAPERED NECK.



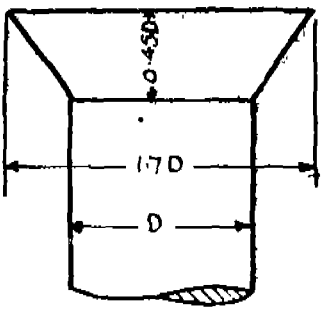
NOTE:- FOR RIVETS UPTO 5 DIAMETERS LONG, THE DIFFERENCE IN CROSS DIAMETERS IS NOT TO EXCEED 0.2 MM. (1/128 IN.). FOR RIVETS ABOVE 5 DIAMETES LONG THE DIFFERENCE IN CROSS DIAMETERS IS NOT TO EXCEED 0.4 MM. (1/64 IN.). THE DIAMETER OF SHANK ANYWHERE SHALL NOT BE GREATER THAN THE MAXIMUM SPECIFIED AT POSITION 'X' OR LESS THAN THE MIN. SPECIFIED AT POSITION 'Y' OR 'Z'

FORMS AND DIMENSIONS OF BOILER RIVETS
AS MANUFACTURED.

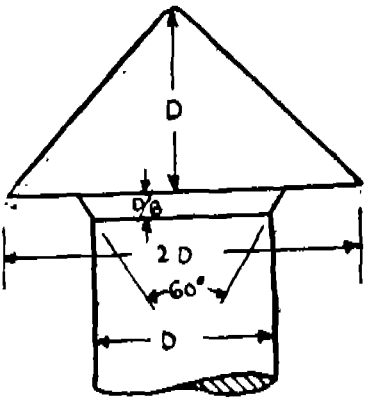
HEADS FOR BOILER RIVETS.



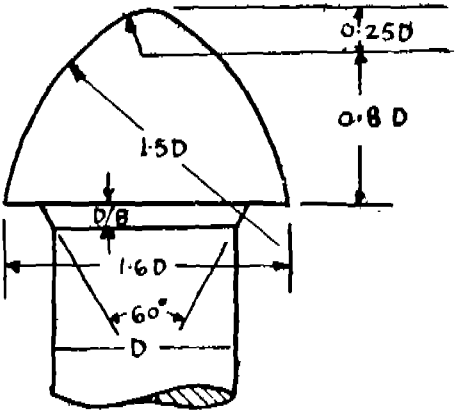
ROUND COUNTERSUNK HEAD



COUNTERSUNK HEAD



STEEPLE HEAD



CONICAL HEAD

(95) For regulation 172-B, the following regulation shall be substituted, namely :—

172-B. *Tolerances on shanks.*—The tolerances on the diameters of the shanks measured at position XX, YY, ZZ as shown in sketch 2, Appendix H-4, shall be within the limits given in table below :—

DIAMETER OF SHANKS

Reference position as shown in sketch-2 Appendix H-4	Distance from rivet head or end	For rivets 5D and below in length		For rivets over 5D in length	
		Max.	Min.	Max.	Min.
XX . .	$\frac{D}{8}$ +3mm (1/8 in)	D+0·4mm (1/6 in.) for D=25 mm (1 in.) and under	D	D+0·4mm (1/6 in.) for D=25 mm (1 in.) and under	D
YY . .	$\frac{D}{2}$ from end	D	D—0·4 mm or D—1/64 in.	D	D—0·4 mm or (D—1/64 in.)
ZZ . .	$\frac{D}{2}$ from end	..	..	..	D—0·4mm or (D—1/64 in.)

(96) in sub-Regulation (2) of Regulation 172-C, for the figures and abbreviation "1/16 in." the figures, abbreviation and brackets "1·6 mm (1/16 in.)" shall be substituted ;

(97) in Regulation 175, for the figures, symbol and abbreviation "500° F", the figures, abbreviations and brackets "260° C (500° F)" shall be substituted ;

(98) for clauses (a) and (b) of Regulation 176 the following clauses shall be substituted, namely:—

176. *Formula for working pressure of shell.*—(a) For cylindrical shells, barrels, steam and water drums, and domes of boilers the maximum working pressure to be allowed shall be calculated from the following formula:—

[Note.—Where the parts of drums of water tube boilers are perforated for tubes, the working pressure shall be calculated by equation under "Tube plates".]

$$W.P. = \frac{(t \cdot C_1) \times S \times J}{70 \times C \times D} \quad \text{.....Eqn. (1)}$$

Where W.P. =the working pressure

t =the thickness of shell plate

S =the minimum tensile breaking strength of shell plate or whatever strength is allowed under regulation 5.

J =the percentage strength of the longitudinal seams of shell or of a line of holes in the shell for stays, or rivets, or of an opening in the shell not fully compensated whichever is least calculated by the methods hereafter described ;

C_1 =0·16 cm (0·06 inches)

C is a co-efficient as follows :—

2·75 When the longitudinal seams are made with double butt straps and when small shells are formed from soilid rolled sections ;

2·83 When the longitudinal seams are made with lap joints and are treble riveted;

2·9 When the longitudinal seams are made with lap joints and are double riveted;

3·0 When the longitudinal seams are welded and are fitted with a single butt strap ;

3·3 When the longitudinal seams are made with lap joints and are single riveted;

D=the inside diameter of the outer strake of plating of the cylindrical shell.

(b) The Factor of safety sh all in no case be less than 4. The actual Factor of safety in each case may be found from the equation :—

$$F = 1{\cdot}4 \times C \times \frac{t}{t - C_1}$$ Where C_1=0·16 cm (0·06 inches) ;

(99) in Regulation 177, for the portion beginning with the words "Where P is pitch of rivets at outer ....." and ending with "Regulation 5 in Chapter I", the following portion shall be substituted, namely :—

Where P is the pitch of rivets at outer row,

D is the diameter of river holes,

A is the sectional area of one rivet hole,

N is the number of rivets per pitch (P)

T is the thickness of plate,

C=1 for rivets in single shear as in lap joints, and 1·875 for rivets in double shear as in double butt strapped joints.

S_1 is the shearing strength of rivets, which shall be taken to be 36·22 kg/mm^2 (23 tons/sq. in.) for steel and 28·35 kg/mm^2 (18 tons/sq. in.) for iron.

S is the minimum tensile breaking strength of shell plate in kg/mm^2 (tons/sq. in.) or whatever strength is allowed under Regulation 5 of Chapter I ;

(100) in Regulation 182,—

(*i*) for the figures and word "3/8 inch", the figures, abbreviations, brackets and word "10 mm (3/8 inch)" shall be substituted ;

(*ii*) in the Equation "Where T, is the thickness of the butt straps in inches ..... Regulation 177", the words "in inches" shall be omitted ;

(101) for Regulation 183, the following regulation shall be substituted, namely :—

183. *Maximum Pitch of Rivets in longitudinal joints* —The maximum pitch of rivets in the longitudinal joints of boiler shells shall be :—

$C \times T + C_1$ =Maximum pitch

Where T =the thickness of the shell plate

C_1 =41 mm (1·625 inches)

C is a co-efficient as given in the following table :—

Number of Rivets per pitch	Co-efficients for Lap joints	Co-efficients for single Butt-strapped joints	Co-efficients for double Butt-strapped joints
1	1·31	1·53	1·75
2	2·62	3·06	3·50
3	3·47	4·05	4·63
4	4 14	..	5·52
5	..	..	6·00

(102) In clause (c) of Regulation 184, in the last sentence, the words "in inches" shall be omitted ;

(103) for Regulation 185, the following Regulation shall be substituted, namely :—

185. *Circumferential and End seams of water tube Boilers.*—The suitability of circumferential seams including the seams joining ends to shells shall be varified by the following formula :—

$$\frac{K \times J \times (t - C_1)}{D \times C} \text{ is equal to or greater than WP} \quad \text{.....Eqn. (17)}$$

Where K = 10·55 kg/cm² for 41/47 kg/mm² tensile plates (150 lbs/sq. in. for 26/30 tons sq. in tensile plates)
= 11·04 kg/cm² for 44/50·0 kg/cm² tensile plates (157 lbs/sq. in. for 28/32 tons/sq. in. tensile plates)
For material of higher tensile strength see Reg. 271 and 340 & use permissible stress

$$K = \frac{\text{permissible stress}}{100}$$

WP = the working pressure
D = the diameter of shell, measured inside the outer ring of plates
J = Circumferential joint efficiency calculated by Eqn. 2 or 3.
C = 0·257 where the seams are made with lap joints and are treble riveted,
= 0·264 where the seams are made with lap joints and are double riveted.
= 0·300 where the saeams are made with lap joints and are single riveted.
T = Thickness of plate
C_1 = 0·16 cm (0·06 inch).

(104) In Regulation 186, for the portion beginning with "Where W is the width of composition ....." and ending with "be included in the compensating section", the following portion shall be substituted, namely :—

Where W is the width of compensation ring measured in the direction of the longitudinal axis of the boiler,

L is the length of opening in shell measured in the direction of the longitudinal axis of the boiler,

D is the diameter of rivet holes
Tr is the thickness of compensation ring
Ts is the thickness of shell plate
A is the area of one rivet hole
N is the number of rivets on one side of the longitudinal line.

When the rivets are in double shear 1·875 times the single rivet section shall be allowed Parts of raised manhole mouth pieces within 102 mm (four inches) of the shell shall, in addition to the ring be included in the compensating section.

(105) In Regulation 187, for the portion beginning with "Where d is ....." and ending with "Eqn. (22)", the following portion shall be substituted, namely :—

Where d = maximum mean effective diameter of uncompensated hole
T = thickness of drum shell
D = internal diameter of drum but not exceeding 1524 mm (60 in.)
N = 76mm (3 in.) where E does not exceed 0·50
= 76 mm $\sqrt{\frac{1 - E}{0{\cdot}50}}$ (3 in.) $\sqrt{\frac{1 - E}{0{\cdot}50}}$ in other cases—Eqn. (21)

Where The required thickness of a seamless unpierced shell

$$E = \frac{\text{The required thickness of a seamless unpierced shell}}{\text{actual thickness of shell}} \quad \text{Eqn. (22)}$$

(106) For regulation 188, the following regulation shall be substituted, namely :—

188. *Complete hemisphere without stays or other support made of one or more plates and subject to internal pressure.*—The maximum working pressure shall be determined by the following formula :—

$$W.P. = \frac{(t-C_1) \times S \times J}{70 \times C \times R} \quad \ldots\ldots \text{Eqn. (23)}$$

Where W.P. is the working pressure,
t is the thickness of the end plates,
S is the minimum tensile breaking strength of the end plates or whatever strength is allowed for them,
J is the least percentage of strength of the riveted joints of the plates forming the hemisphere or securing it to the cylindrical shell,
R is the inner radius of curvature
C for single riveting is 3·3,
C for double riveting is 2·9,
C for treble riveting is 2·83.

(107) for clauses (*a*), (*b*) and (*e*) and the note below clause (*e*) of Regulation 189 the following clauses and note shall be substituted, namely :—

189. *Dished ends subject to internal pressure.*—(*a*) For unstayed ends of steam and water drums, tops of vertical boilers, etc., when dished to partial shperical form the maximum working pressure shall be determined by the following formula :—

$$W.P. = \frac{15\ S\ (t-c)}{70\ R} \quad \ldots\ldots\ldots \text{Eqn. (24)}$$

Where W.P. is the working pressure,
t is the thickness of end plates,
R is the inner radius of curvature of the end, which shall not exceed the external diameter of the shell to which it is attached,
S is the minimum tensile breaking strength of plate or whatever is allowed for it.
C = 0·08 cm (0·03 inch).

(*b*) The inside radius of curvature at the flange shall be not less than 4 times the thickness of the end plate, and in no case less than 64mm (2½ inches)

(*c*) When the end has a manhole in it, the value of C is to be taken as 0·4 cm (0·156 inch.)

(*e*) The total depth of flange of manhole from the outer surface measured on the minor axis shall be at least equal to :—

$\sqrt{T \times W}$ = depth of flange ....Eqn. (25)

Where T is the thickness of the plate and
W is the minor axis of the hole.

Note:—The foregoing provisions shall not preclude the use of dished ends in compliance with Regs. 275 to 278 where not fitted with an uptake.

(108) For regulation 191, the following regulation shall be substituted, namely:—

191. *Dished ends of Lancashire and Cornish type Boilers.*—(*a*) For dished ends of Lancashire and Cornish Boilers with external or internal flanges for furnaces formed in one piece, without stays and subject to internal pressure, the maximum working pressure shall be determined by the following formula :—

$$W.P. = \frac{(t-c)\ 30\ S}{70R} \quad \ldots\ldots\ldots \text{Eqn. (26)}$$

Where W.P. is the working pressure
t is the thickness of the end plate
R is the inner radius of curvature of the end which shall not exceed one and half times the external diameter of the shell to which it is attached.
S is the minimum tensile breaking strength of the plate or whatever is allowed for it.
C = 0·6 cm (0·25 inch)

(*b*) The inside radius of curvature at the flange shall be not less than 4 times the thickness of the plate and in no case less than 89mm (3-1/2 inches).

(109) In clause (*b*) of Regulation 192, the words "in inches" shall be omitted;

(110) in Regulation 193, (*i*) for clause(*a*), the following clause shall be substituted, namely:—

193. *Flat plates supportd by solid screwed stays, marginal seams or flanges.*—(*a*) For plain flat plates supported by solid screwed or riveted marginal seams or flanges maximum working pressure shall be as follows :—

$$W.P. = \frac{C\ (t-c_1)^2}{A^2+B^2} \quad \ldots\ldots\ldots \text{Eqn. (28)}$$

In this formula and in those following in the succeeding regulations relating to "Flat Plates" unless otherwise specified—

W.P. is the working pressure,

T is the thickness of the flat plate,

T_1 is the thickness of the washers, strip, or doublings employed.

A is the horiontal pitch of stays,

B is the vertical pitch of the stays,

c_1 = 0·08 cm (0·03) inch

C is a co-efficient which varies in value with the method of fixing the stays and nature of the support.

Where the plates are exposed to the direct impact of the flame the following values of C shall be reduced by 12½ percent.

C=4319 kg/cm² (61,440 lbs./sq. in.) for stays screwed into the plate with their ends riveted over,

C=6,479 kg/cm² (92,160 lbs./sq. in.) for stays screwed into the plate and fitted with plus nuts on the outside,

C=7199 kg/cm² (102,400 lbs./sq. in.) for stays passed through the plate and fitted with nuts inside and outside,

C=7919 kg/cm² (112,640 lbs./sq. in.) for a riveted seam or flange in the flat plate securing it to the shell side plate, end plate, furnace or uptake.

Where portions of plate are supported by stays or riveted seams or flanges having various values of support, the value of C, shall be taken as the mean of the points of support concerned. The support of a riveted seam shall be assumed to be at the line through the centres of rivets in the nearest row and of a flange at the commencement or curvature. In the letter case, if the inner radius of curvature of the flange exceeds 2½ times the thickness of the plate, the support shall be assumed to be at a distance of 2½ times the thickness of the plate from the inner side of the flange.

(*ii*) in clause (*b*), the words "in inches" shall be omitted ;

(111) in Regulation 194, for Equations (29), (30), (31) and (32), the following equations shall respectively be substituted, namely —

$$W.P. = \frac{C}{A^2+B^2}\ [(t-C_1)^2+15\,t_1^2] \quad \text{.....Eqn. (29)}$$

Where C=7199 kg/cm² (102,400 lbs/sq.in.)

$$W.P. = \frac{C}{A^2+B^2}\ [(t-C_1)^2+.35t_1^2] \quad \text{.....Eqn. (30)}$$

Where C=7199 kg/cm² (102,400 lbs./sq. in).

$$W.P. = \frac{C}{A^2+B^2}\ [(t-C_1)^2+\cdot55t_1^2] \quad \text{.....Eqn. (31)}$$

C=7199 kg/cm² (102,400 lbs./sq. in).

$$W.P. = \frac{C}{A^2+B^2}\ [(t-C_1)^2+\cdot85\,t_1^2] \quad \text{.....Eqn. (32)}$$

Where C=7199 kg/cm² (102,400 lbs./sq. in).

(112) in Regulation 195,—

(*i*) for equation (33) and entries below it in clause (*a*), the following equation and entries shall be substituted, namely :—

$$W.P. = \frac{C\,(t-C_1)^2}{P^2} \quad \text{.....Eqn. (33)}$$

Where P is the mean pitch of stay tubes supporting any portion of the plate (being the sum of the four sides of the quadrilateral divided by four),

C=5039 kg/cm² (71,680 lbs./sq. in.) for stay tubes screwed and expanded into the plate and no nuts fitted,

C=6119 kg/cm² (87,040 lbs./sq. in.) for stay tubes screwed and expanded into the plate and fitted with nuts.

(*ii*) for clause (*d*), the following clause shall be substituted, namely :—

(*d*) For the wide water spaces of tube plates between the nests of tubes and between the wing rows of tubes and shell, the maximum working pressure shall be:—

$$W.P. = \frac{C}{A^2+B^2}[(t-C_1)^2 + .55t_1^2] \ldots\ldots\ldots\ldots\ldots \text{Eqn.(34)}$$

Where, A = the horizontal pitch of stay tubes measured across the wide water space from centre to centre,

B = the vertical pitch of stay tubes in the bounding rows measured from centre to centre.

C = 4319 kg/cm^2 (61,440 lbs./sq. in.) for stay tubes screwed and expanded into the tube plates and no nuts are fitted,

C = 5759 kg/cm^2 (81,920 lbs./sq. in.) for stay tubes screwed and expanded into the tube plates and fitted with nuts.

C = 5039 kg/cm^2 (71,680 lb./sq. in.) for stay tubes screwed and expanded into the tube plates and nuts are fitted only to alternate stay tube,

t is the thickness of the flat plate

t_1 is the thickness of the washers, strips or doublings employed,

C = 0·08 cm (0·03 inch).

(113) in Regulation 196,—

(*i*) for Equation (35) and entries below it in clause (*a*), the following equation shall be substituted, namely :—

$$W.P. = \frac{C(t-C_1)}{D^2} \ldots\ldots\ldots \text{Eqn. (35)}$$

Where D = the diameter of the largest circle which can be drawn passing through not less than three points of support viz. the centre line of rivets or the commencement of the curvature of flanging, whichever is applicable,

C = 7199 kg/cm^2 (102,400 lbs./sq. in.) for plates not exposed to flame,

C = 6335 kg/cm^2 (90,112 lbs./sq. in.) for plates exposed to flame,

C = 0·08 cm (0·03 inch).

(*ii*) For clause (*c*) the following clause shall be substituted, namely :—

(*c*) For the part of the end plate containing the manhole in Lancashire boiler, the maximum working pressure shall be :—

$$W.P. = \frac{C}{D^2}\left[(t-C_1)^2+(t_1-C1)^2\right] \ldots\ldots\ldots\ldots \text{Eqn. (36).}$$

Where D is the diameter of the largest circle which can be drawn enclosing the manhole and passing through the centres of the rivets in end plates connecting the shell and gusset angles and furnaces or to the commencement of the curvature of flanging, whichever is applicable. Where the circle passes through only three of the possible five points of support mentioned, the remaining two shall be embraced within the circle.

t is the thickness of the end plates,

t_1 is the thickness of the base of the mouthpiece or flat ring.

C = 6479 kg/cm^2 (92,160 lbs./sq. in.) where the manhole mouthpiece is either of mild or cast steel, and has a turned-in flange of a depth, measured from inside of end plate, of not less than four times the thickness of the end plate, and thickness not less than the thickness of the end plate.

C = 5039 kg/cm^2 (71,680 lb./sq. in.) where only a flat steel compensating ring is fitted ;

C is to be taken as the mean of the points of support through which circle passes in accordance with Regulation 193 where there is no mouthpiece of flat ring and the end plate is flanged around the manhole to the depth required in Regulation 201.

(114) for clauses (*a*) and (*b*) of Regulation 197, the following clauses shall be substituted namely :—

197. *Flat Crown plates of Vertical boilers.*—(*a*) For the flat crown plates of vertical boilers either with or without bolt stays, Equation (35) shall be used in determining the working pressure with C = 5759 kg/cm^2 (81,920 lbs./sq. in.) when the plates are not exposed to flame, and 5039 kg/cm (71,680 lbs./sq. in.) when they are exposed to flame. In this case D is the diameter of the largest circle that can be drawn passing through the centres of the rivets or bolt stays when fitted,

of the curvature of the flanging, whichever is applicable. Where bolt stays are fitted with washers of the same thickness as the plate securely rivetted thereto, the circle shall pass through the centres of the washer rivets but where the washers are not riveted or where none are fitted the circle shall pass through the centre of the stays.

(*b*) Where the crown plate is flanged the inside radius of curvature at the flange shall not be less than 4 times the thickness of the end plate, but in no case less than 64mm (2½ in.),

(115) in Regulation 198,—

(*i*) in clause (*a*), for the figures "140" and "122 5", the figures and abbreviations "10,078 kg/cm² (143,360 lbs./sq. in.)" and "8818 kg/cm² (125,440 lbs./sq. in.)" shall respectively be substituted ;

(*ii*) in clause (b), for the figures and abbreviation "2½ in.", the figures, abbreviations and brackets "64 mm (2½ in.)" shall be substituted ;

(116) for the second paragraph of Regulation 199, the following paragraph shall be substituted namely :—

C shall be taken as equal to 5759 kg/cm² (81,920 lbs/sq. in.) and 5039 kg/cm² (71,680 lbs/sq. in.) for plates not exposed, and exposed, to flame respectively. The margin or pitch for such stiffening shall be measured from the centre line of rivets or commencement of curvature of bulb provided it is not more than 51 mm (2 inches) from the centre line of bulb;

(117) in Regulation 200,—

(*i*) for equation (37), the following equation shall be substituted, namely :—

$$(\text{width of margin})^2 = W^2 = \frac{C\,(t-C_1)^0}{W.\,P.} \quad \ldots\ldots\ldots \text{Eqn. (37)}$$

Where t=thickness

W.P.=Working pressure.

C=867 kg/cm² (12,330 lbs./sq in) for plates exposed to flame.

C=986 kg/cm² (14,018 lbs./sq. in.) for plates not exposed to flame.

C_1= 0 08 cm (0 03 inch).

(*ii*) in the last paragraph, for the figures and word "1½ inch", the figures, abbreviations and brackets "38 mm (1½ in.)" shall be substituted ;

(118) in Regulation 201, for Equation (38) and the entries below it, the following equation shall be substituted, namely —

"$\sqrt{T \times W}$=depth of flange

Where T=the thickness of the plate, and
W=the minor axis of the hole.",

(119) for Regulation 202, the following Regulation shall be substituted, namely:—

202. *Solid screwed stays* —For screw stays to combustion chamber and fireboxes and for longitudinal and cross stays, the maximum working pressure for the stays is to be calculated from the appropriate one of the following two formulae :—

$$W.P. = \frac{C(D-C_1)^2}{A} \quad \ldots\ldots \text{Eqn. (39)}$$

$$W.P. = \frac{CD_1^2}{A} \quad \ldots\ldots\ldots \text{Eqn. (40}$$

Where W.P.=the working pressure,

D=the diameter of stays over threads,

D_1=the diameter of the body of stay at its smallest part,

A=the area supported by one stay [for area to be supported by stays near tubes in firebox tube plates of locotype boilers see regulation 193(*e*)],

C=499 kg/cm² (7100 lbs /sq. in) for steel or special wrought iron screw stays to combustion chamber or fireboxes,

C=607 kg/cm² (8640 lbs./sq. in.) for steel longitudinal or cross stays fitted with nuts,

C=330 kg/cm² (4700 lbs./sq. in.) for copper screw stays to fireboxes.

C_1=1 299 p.cm ² being the pitch of threads in cm.

or= $\frac{(1\ 28)}{N}$ inches, N being the number of threads per inch.

Where stays are made with enlarged ends and the body of the stay is smaller in diameter than at the bottom of the thread, the working pressure shall be calculated from the second formula.

(120) for clause (*a*) of regulation 203 the following clause shall be substituted, namely :—

203. *Stresses in steel jointed stays.*—(a) The section of least strength whether of stay, rivets, shackle or pin shall be used in calculating the working pressure for the stay. For parts in tension a stress of 6·328 kg/mm² (9,000 lbs./sq. in.) of net section shall be allowed, and for parts in shear stress of 5·624 kg/mm² (8,000 lbs./sq. in.) of net section.

(121) for regulation 204, the following regulation shall be substituted, namely :—

204. *Stay tubes.*—For stay tubes, whether of wrought iron or steel, seamless or electric-resistance-welded or lapwelded, the maximum working pressure shall be calculated from the following formula :—

$$W.P. = \frac{C}{A}[(D-C_1)^2 - D_1^2] \quad \text{.....Eqn. (41)}$$

Where D = the diameter of the tube over threads,

D_1 = the internal daimeter of the tube under the threads,

C_1 = 1·299 P cm, P being the pitch of thread in cm.

$\left(\frac{1\cdot28}{N}\right.$ inch, N being the number of threads of stay per inch.)

C = 415 kg/cm² (5900 lbs./sq. in.)

A is the area supported by one stay tube, measured from centre to centre of stay tubes. When the area contains tubes or parts of tubes their aggregate area, calculated from their smallest external diameter of body when in tension and smallest internal diameter when in compression, shall be deducted from the area of the containing figure and the remainder used as A in the formula.

(122) for regulation 207, the following regulation shall be substituted, namely :—

207. *Gusset stays.*—The maximum working pressure for gusset stays shall be calculated by the following formula :—

$$W.P. = \frac{C_2 C}{A} \quad \text{.....Eqn. (42)}$$

Where C_2 = 633⅓ kg/cm² (9,000 lbs/sq. in.) and

C, the co-efficient, is the number repesenting the least of the following :—

(1) $N_1 \times A_1$

(2) $N_2 \times A_2 \times 1\cdot875$

(3) $N_3 \times A_3 \times 1\cdot875$

(4) $N_4 \times A_4$

(5) $(G - N_3 D_3)(t - c_1) \times 1\cdot184$

(6) $(G_1 - D_3)(t - c_1) \times 1\cdot184$

$N_1, N_2, N_3, N_4, D_1, D_2, D_3, D_4$ and A_1, A_2, A_3, A_4, are respectively the numbers, diameters and sectional areas of the rivets in the joints of each gusset stay, only rivets in the supported area, to be considered effective, the order of the joints being (1) angles to end plate, (2) end plate angles to gusset, (3) shell angles to gusset, and (4) angles to shell,

C_1 = 0·16 cm (or 0·06 in.)

G is the depth of gusset plate measured through the line of attaching it to the end plate angles,

G_1, is the depth of gusset plate measured normal to the slant edge of plate through the rivet nearest to the end plate in the joint attaching gusset plate to shell angles,

t, is the thickness of gusset plate,

A is the area of flat plate supported by the gusset stay which, in the case of Lancashire and Cornish boiler, shall be determined as follows:—

(*a*) The margins allowed under flat plate regulations for shell and furnaces be marked on end plates and the lengths of the centre lines of gussets between them measured, also the distance between each pair of gusset lines from the middle of the smaller in a direction normal to the greater. If L and L_1 be the lengths of two adjacent gusset lines and if the distance between them be W the area contained by the gusset lines and the shell end furnace margin lines may be apportioned between the stays thus :—

$\frac{W(3L+L_1)}{8}$ = Portion of area apportioned to L line gusset ..... Eqn. (43)

$\frac{W(3L_1+L)}{8}$ = Portion of area apportioned to L_1 line gusset.....Eqn. (44)

(*b*) ne ie area on the other side of each gusset line shall except when of triangular form, be found in like manner and its amount added to that already found to form the total.

(*c*) For the triangular portion in the wing spaces the area shall be taken as half the product of the length of gusset line into the perpendicular distance between it and the intersecting point where the marginal curves meet.

(123) For clause (*b*) of regulation 208, the following clause shall be substituted, namely :—

(*b*) The maximum working pressure for the bolts or studs shall be calculated by the following formula :—

$$W.P. = \frac{N \times C}{A} (D - C_1)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eqn. (45)}$$

Where D is the diameter of bolt or stud over threads,

N is the number of bolts or studs securing the part,

$C_1 = 1 \cdot 299$ P cm, P being the pitch of thread in cm,

($1 \cdot 28/n$ inches, n being the number of threads per inch).

C=330 kg/cm² (4,700 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² (28 tons/sq.in.) minimum ultimate tensile stress where the diameter over thread is less than 19mm ($\frac{3}{4}$ in.).

C=359 kg/cm² (5,100 lbs/sq. in.) for steel bolts or studs of 47 kg/mm² (30 tons/sq. in minimum ultimate tensile stress where the diameter over thread is less than 19mm ($\frac{3}{4}$ in.).

C=394 kg/cm² (5,600 lbs/sq. in.) for steel bolts or studs of 55 kg/mm² (35 tons/sq. in.) minimum ultimate tensile stress where the diameter over thread is less than 19mm ($\frac{3}{4}$ in.).

C=394kg/cm² (5,600 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² (28 tons/sq. in.) minimum ultimate tensile stress where the diameter over thread is not less than 19mm ($\frac{3}{4}$ in.) and not greater than 22mm (7/8 in.).

C=492 kg/cm² (7,000 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² (28 tons/sq. in.) minimum ultimate tensile stress where the diameter over thread is greater than 22mm (7/8 in.). When the material is iron, a reduction of 15 per cent shall be made in the working pressure as calculated by the formula. A is the area of the surface supported by the bolts or studs. For jointed flanges, the area shall be taken to extend to midway between the pitch line of the bolts and the inner edge of the flange by which the part is secured.

(124) in Regulation 209,—

(*i*) for Equation 46 and entries below it in clause (*a*), the following shall be substituted, namely :—

$$W.P. = \frac{C \times (P-D) \times t}{L \times P} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eqn. (46)}$$

Where t is the thickness of the tube plate,

P is the pitch of tubes, measured horizontally where the tubes are chain pitched and diagonally where the tubes are zig-zag pitched and the diagonal pitch is less than the horizontal.

D is the internal diameter of the plain tubes.

L is the internal length of firebox or combustion chamber measured at top between tube plate and firehole plate or back plate, or between tube plates in double ended boilers with combustion chambers common to two opposite furnaces,

C=1969 kg/cm² (28,000 lbs/sq. in.) and 984·5 kg/cm² (14,000 lbs/sq. in.) for steel and copper respectively.

Provided that the above formula shall not apply in the case of fireboxes where the girders do not rest on the tube plate, or where the roof plate is stayed direct to the outer shell or to girders supported by the shell.

(*ii*) For clause (*b*) the following clause shall be substituted, namely :—

(*b*) Where girders rest on the side plates or the roof plate is so formed that the load is carried both by side and end plates, in no case shall the compressive stress on the plates exceed 9.845 kg/mm² (14,000 lbs/sq. in.) for steel or 4.922 kg/mm² (7,000 lbs/sq. in.) for copper.

(125) For regulation 211, the following regulation shall be substituted, namely :—

211. *Minimum thickness and cross section.*—To provide a secure attachment for plain tubes in the tube plates, the thickness and cross section of the plate between the tube holes shall not be less than :—

Steel tube plate,

·125 D+C=minimum thickness

Where C=5mm (0·2 inch).....Eqn. (47)

KD+C_1=minimum cross section

where K=4·3mm (0·17 inch).....Eqn. (48)

C_1=16 13mm² (0·025 sq. in.)

Copper tube plate,

·2D+C_2=minimum thickness where

C_2=10mm (0·4 inch).....Eqn. (49)

K_1D—C_3=minimum cross section

where K_1=13·38 mm (0·527 in.) and

C_3=169·67mm² (0·263 sq. in).....Eqn. (50)

D is the diameter of the tube at the part of attachment.

Where the thickness and cross section of tube plate are less than the minimum the appropriate coefficient in Eqn. (51) shall be reduced in proportion to the deficit.

(126) for clause (*a*) of regulation 212, the following clause shall be substituted, namely :—

212. *Holding power of plain tubes.*—(*a*) Where tube plates are not specially stayed in nests of tubes, the working pressure based on the holding power of the tubes shall not exceed that found by the following formula :—

$$W.P. = \frac{C \times D}{A} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eqn. (51)}$$

Where D=the diameter of tube at the part of attachment to tube plate.

A=the area of tube plate supported by each tube which generally may be taken as the product of the horizontal and vertical pitches of the tubes less the area of the tube itself.

C=83·9 kg per cm (470 lb per in.) of diameter of tubes for tubes expanded into parallel holes in steel or iron tube plates.

C=94·6 kg per cm (530 lb per in.) of diameter of tubes, for tubes expanded into taper holes in steel or iron tube plates.

For copper tube plates or copper or brass tubes the appropriate co-efficient should be deducted 20 per cent.

(127) for Equation (52) in clause (*b*) of Regulation 213 and the entries below it, the following shall be substituted, namely :—

$$W.P. = \frac{17{\cdot}24\,(t-C)\quad(P-D)\,S}{70\,RP} \quad \ldots\ldots \text{Eqn. (52)}$$

Where t is the thickness of the tube plate,

P is the vertical pitch of tubes,

D is the diameter of the tube holes,

S is the minimum tensile breaking strength of the tube plates or whatever is allowed for them,

R is the radial distance of the centre of the outer row of the tube holes from the axis of the shell.

C=0·16 cm (0·06 inch.)

(128) in Regulation 214, for Equation (53) and the entries below it, the following shall be substituted, namely :—

$$W.P. = \frac{33{\cdot}3\,(t-C)\,ES}{70\,D} \quad . \quad . \quad . \quad . \quad . \quad \text{Eqn. (53)}$$

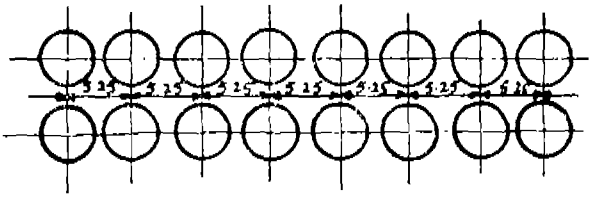
Where t=thickness of tube plate,

E=Percentage efficiency of the longitudinal joint or the ligament between the tube holes whichever is less,

S=Minimum Tensile stress of the tube plate or whatever is allowed for it,

D=Inside diameter of the drum,

C=0·32 cm (0·125 inch.)



LONGITUDINAL LINE——►

EXAMPLE OF TUBE SPACING WITH PITCH OF HOLES EQUAL IN EVERY ROW.

FIG. 10.

(129) For clauses (*a*), (*b*) and (*d*) of regulation 215, the following clauses shall be substituted namely :—

215. *Efficiency of ligament.*—(*a*) When a shell or drum is drilled for tubes in a line parallel to the exis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows :—

(*a*) When a pitch of the tube holes on every row is equal [as in Fig. (10)], the formula is:—

$$\frac{p-d}{p} = \text{efficiency of ligament} \ldots\ldots \text{(Eqn. 54)}.$$

Where P = pitch of tube holes,
d = diameter of tube holes

The pitch of tube holes shall be measured on the flat plate before rolling or on the median line after rolling.

Example.—Pitch of tube holes in the drum as shown in Fig. 10 = 5·25 Diameter of tube = 3·25 Diameter of tube holes = 3·281.

$$\frac{p-d}{p} = \frac{5{\cdot}25-3{\cdot}281}{5{\cdot}25} = 0{\cdot}375 \text{ efficiency of ligament}$$

Example.—Spacing shown in Figure 11.

Diameter of tube holes = 3·281.

$$\frac{p-nd}{p} = \frac{12-2\times 3{\cdot}281}{12} = 0{\cdot}453$$

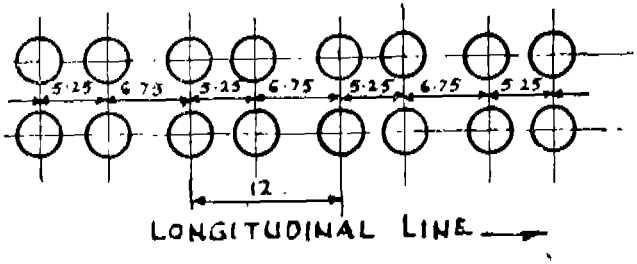
(*b*) When the pitch of tube holes on any row is unequal (as in Figs. 11 and 12), the formula is :—

$$\frac{p-nd}{p} = \text{efficiency of ligament} \ldots\ldots \text{Eqn. (55)}.$$

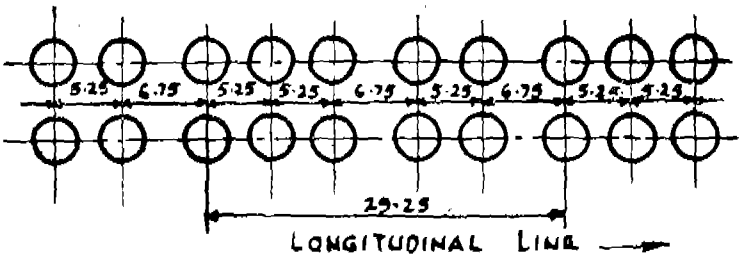
Where P = Unit length of ligament,
n = number of tube holes in length " P ".
d = diameter of tube holes,

Example.—Spacing shown in Fig. 12. Diameter of tube holes = 3·281.

$$\frac{p-nd}{p} = \frac{29{\cdot}25-5\times 3{\cdot}281}{29{\cdot}25} = 0{\cdot}439, \text{ efficiency of ligament.}$$



EXAMPLE OF TUBE SPACING WITH PITCH OF HOLES EQUAL IN EVERY SECOND ROW.
FIG. 11.



EXAMPLE OF TUBE SPACING WITH PITCH OF HOLES VARYING IN EVERY SECOND AND THIRD ROW.

FIG. 12.

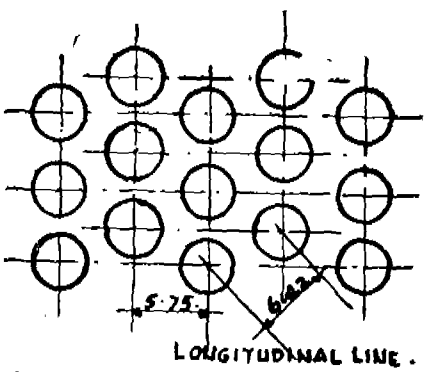
(*d*) When a shell or drum is drilled for tube so as to form diagonal ligaments as shown if Fig. 13, the efficiency of these ligaments shall be that given by the diagram in Fig. 14

In this diagram the abscissas are $\frac{p}{d}$ and the ordinates $\frac{p^1}{p}$

Where p = longitudinal pitch of tube holes, or distance between centres of tubes in a longitudinal row,

p^1 = diagonal pitch of tube holes,

d = diameter of tube holes,



EXAMPLE OF TUBE SPACING WITH TUBE HOLLES ON DIAGONAL LINES.

FIG. 13

To use the diagram in Fig. 14, the values of p/d and $\frac{p^1}{p}$ are computed and the efficiency for the corresponding points is read off from the diagram. Should the point fall above the curve of equal efficiency for the diagonal and longitudinal ligaments, the longitudinal ligaments will be the weaker, in which case the efficiency is computed from the following formula :—

$$\frac{p-d}{p}$$

Example.—(1) Diagonal pitch of tube holes in drum as shown in Fig. 13.
= 6·42.

Diameter of tube holes = 4·031.

Longitudinal pitch of tube holes = 11·5.

$\frac{p}{d} = \frac{11·5}{4·031} = 2·853$, $\frac{p^1}{p} = \frac{6·42}{11·5} = 0·558$.

The point corresponding to these values is shown at A on the diagram in Fig. 14 and the corresponding efficiency is 35·3 per cent. As the point falls below the curve of equal efficiency for the diagonal and longitudinal ligaments, the diagonal ligament is the weaker.

... of tube ... es in crum . . . . . 6·547

Diameter of tube holes . . . . . 4·0156

longitudinal pitch of tube holes . . . . . 7·0

$$\frac{p}{d}=\frac{7}{4\cdot0156}=1\cdot743,\quad \frac{p^1}{p}=\frac{6\cdot547}{7}=0\cdot935$$

The point corresponding to these values is shown at B on the diagram in Fig. 14 and it will be seen that it falls above the line of equal efficiency for the diagonal and longitudinal ligaments in which case the efficiency is computed from formula (1)

Applying formula (1), we have :—

$$\frac{7-4\cdot0156}{7}=0\cdot426 \text{ efficiency of ligaments, or } 42\cdot6 \text{ per cent.}$$

For holes placed longitudinally along a drum but which do not come in a straight line, the above rules for calculating efficiency shall hold, except that the equivalent longitudinal width of a diagonal ligament shall be used. To obtain the equivalent width the longitudinal pitch of the two holes having a diagonal ligament shall be multiplied by the efficiency of the diagonal ligament. The efficiency to be used for the diagonal ligament given in Fig. 15.

(130) For regulation 218, the following regulation shall be subsituted, namely :

218. *Steel and Wrought Iron Tubes.*—(*a*) The maxium working pressure for the tube shall be :—

$$\text{W.P.}=\frac{C(t-C_1)}{D} \quad \ldots\ldots\ldots\ldots \text{Eqn. (56)}$$

Where t =the thickness of the tubes,

D =the external diameter of the tubes

C = 703 kg/cm² (10,000 lbs./sq. in).

C_1=0·16 cm (0·06 inch).

(*b*) No tube shall be less than 2·64 mm (0·104 in.) thick.

(131) For regulation 219, the following regulation shall be substituted namely :—

219. *Brass and Copper Tubes.*—The thickness of tapered brass and copper smoke tubes for locomotive boilers shall, in the case of tubes of an external diameter of 38 mm (1½ in.) to 48mm (1·7/8 in.) inclusive, be not less than 2·64 mm (0·104 in.) at the smoke box end and 3·25 mm (0·128 in.) at the other end ; in the case of tubes of an external diameter of 51mm (2 in.) to 61mm (2·3/8in.) inclusive, the thickness at the smoke box and shall not be less than 2·9 mm (0·116 in.) and at the other and not less than 3·6 mm (0·144 in.)

(132) In Regulation 220, for Equations (57) and (58) and the entries below them, the following Equations and entries shall be substituted, namely :—

$$\text{W.P.}=\frac{C}{D}X\frac{(t-C_1)^2}{(L+C_2)}X\frac{(t-C_1)^2}{(L-C_2)} \quad \ldots\ldots \text{Eqn. (57)}$$

$$\text{W.P.}=\frac{C_3}{D}X[320\ (t-C_1)-L] \quad \ldots\ldots \text{Eqn. (58)}$$

Where D =the external diameter of the furnace or chamber top or bottom.

t =the thickness of the furnace plate,

L =the length of the furnace or other part measured between points of substantial support *i.e*, centres of rows of rivets in end seams or commencement of curvature of flange, whichever is applicable.

C = 1,04392 kg/cm² or (14,84,800 lbs/ sq. in) where the longitudinal seams of steel furnaces are welded and 93,593 kg/cm² or (13,31,200 lbs/sq. in.) where they are riveted.

C =52,196 kg/cm² (7,42,400 lbs./sq. in.) where the longitudinal seams of circular copper fire boxes or furnaces are fitted with double butt straps and 46,796 kg/cm² or 6,65,600 lbs/sq. in where they are lapped.

C_1 =0·88 cm (0·03 in.)

C_2 =60·96 cm. (24 in.)

C_3 =3·5 kg/cm² or (50 lbs. sq. in.) where longitudinal seams of steel furnaces are welded and 3·2 kg/cm² or (45 lbs/sq. in.) where they are riveted.

C_3 =1·75 kg/ cm² or (25. lbs/sq. in) where the longitudinal seams of circular copper fireboxes or furnaces are fitted with double butt traps and 1·58 kg/cm² or (22·5 lbs/sq. in.) where they are lapped.

(133) In Regulation 221, for Equation (59) and the entries below it, the following Equation and entries shall be substituted, namely :—

$$W.P. = \frac{C}{D}(t - C_1) \quad \ldots\ldots\ldots \text{Eqn. (59)}$$

Where D is the least external diameter measured at the bottom of corrugations on the water side,

t is the thickness of the furnace plate measured at the bottom of the corrugation or chamber,

C = 1080 kg/cm² (15360 lbs/sq. in) for the Fox, Morrison, Deighton, Purves, and other similar furnaces and 1147 kg/cm² (16320 lbs/sq. in. for the Leeds Forge Bulb Suspension Furnace.)

C_1 = 0·08 cm (0·03 inch.)

(134) In Regulation 222, for the figures and abbreviation " 3/4 in" the figures, abbreviations and brackets "19 mm (3/4 in.)" shall be substituted.

(135) In Regulation 223, for Equation (60) and the entries below it, the following shall be substituted, namely :—

$$W.P. = \frac{C(t - C_1)}{R} \quad \ldots\ldots\ldots \text{Eqn. (60)}$$

Where t is the thickness of the top plate,

R is the outer radius of curvature of the furnace,

C = 619 kg/cm² or 8800 lbs/sq. in.,

C_1 = 0·08 cm (0·03 in.)

(136) In Regulation 224, for Equation (61) and entries below it, the following Equation and entries shall be substituted, namely :—

$$W.P. = \frac{C(t - C_1)}{D} \quad \ldots\ldots\ldots \text{Eqn. (61)}$$

Where t is the thickness of the fire box plate.

D is the mean of the external diameters of firebox measured over the plain part of each end at commencement of curvature of flange,

C = 877 kg/ cm² (12480 lbs./sq. in.)

C_1 = 0·08 cm (0·03 in.)

(137) In Regulation 225, for Equation (62) and entries below it, the following Equation and entries shall be substituted, namely :—

$$W.P. = \frac{C(t - C_1)}{D(D - D_1)} \quad \ldots\ldots\ldots \text{Eqn. (62)}$$

Where C = 10,079 kg/cm² (1,43,360 lbs/sq. in.)

C_1 = 0·08 cm (0·03 in.)

t is the thickness of the joggled firebox plate or ogee ring.

D is the inside diameter of boiler shell.

D_1 is the outside diameter of the joggled firebox at the commencement of the curvature above joggled part or the outside diameter of the firebox where it joins the ogee ring.

(138) In regulation 226 (i) for equation (63) and entries below it the following equation and entries shall be substituted, namely :—

$$W.P. = \frac{C(t - C_1)^2 \times (L + W)}{L \times W\,(W - W_1)} \quad \ldots\ldots\ldots \text{Eqn. (63)}$$

Where t is the thickness of the joggled firebox side plates or fire hole plate (whichever is less), or ogee ring,

L is the length of firebox casing measured between the water sides of front end plate and saddle plate at the foundations seam,

W is the width of firebox casing measured between the water sides of casing side plates at the foundation seam,

W_1 is the width of firebox measured between the water sides of the firebox side plates at the commencement of curvature above joggled part or where it joins the ogee ring,

C = 5040 kg/cm² (71680 lbs/sq. in.)

C_1 = 0·08 cm (0·03 in.)

(ii) delete the words "in square inches ".

(139) In regulation 227, for equation (64) and entries below it the following equation and entries shall be substituted, namely :—

$$W.P. = \frac{C(t-C_1)}{D} \quad \text{.....Eqn. (64)}$$

Where W.P. = Working pressure,
t = minimum thickness,
D = the internal diameter of the cross tubes,
C = 450 kg/cm² (6,400 lbs/sq. in.)
C_1 = 0·56 cm (0·218 in.)

(140) (i) In regulation 229, for equation (65) and entries below it the following equation and entries shall be substituted, namely :—

$$W.P. = \frac{C \times S \times T \times D^2}{L^2 \times Y} \quad \text{.....Eqn. (65)}$$

Where W.P. = Working pressure
S = Minimum tensile stress of the material,
T = Total thickness of the stay.
D = Depth of the girder stay,
L = Length of girder stay measured between the inside of the tube plate and the firehole plate,
or between the inside of the side plates, according to the method of support.
Y = Pitch of girder stays.
C = 0·314 for steel plates or steel forgings and 0.271 for steel castings.

(ii) In clause (b) for the figures, abbreviations and words "14,000 lbs. per square inch", the figures, abbreviations, brackets and words "9,843 kg/mm (14,000 lbs. per square inch)" shall be substituted.

(141) In regulation 230 for equations (66) and (67) and entries below them the following equations and entries shall be substituted, namely :—

$$W.P. = \frac{C(t-C_1) \times H^2}{W \times L \times \sqrt{W^2+L^2}} \quad \text{.....Eqn. (66)}$$

$$W.P. = \frac{C_2(t-C_1)^2 \times \left(W+\sqrt{W^2+L^2}\right)^2}{W^2 \times L^2} \quad \text{.....Eqn. (67)}$$

Where t is the thickness of the roof plate,
H is the height of the corrugation the highest part measured perpendicularly on one side of the plate,
W is the width of the roof plate between the flat of side plates at top less the inner radius of curvature of corner of roof and side plate *i.e.* W + radius = internal width of firebox at top,
L is the length of the roof plate between centre lines of rivets,
C = 56246 kg/cm² (80x 10_4./lbs/sq. in.)
C_1 = 0·8 cm (0·03 in.)
C_2 = 3960 kg/cm² (56,320 lbs/sq. in.)

(142) In regulation 231, for equations (68) & (69) and entries below them the following equations and entries shall be substituted, namely :—

$$W.P. = \frac{C}{R} \times \frac{(t-C_1)^2}{L+C_2} \quad \text{.....Eqn. (68)}$$

$$W.P. = \frac{C_3}{R} \times [320\,(t-C_1) - L] \quad \text{.....Eqn. (69)}$$

Where t is the thickness of the corrugated plate,
L is the length of the roof plate between centre lines of rivets,
R is the external radius of the side corrugations at the middle of the length,
C = 26,134 kg/cm² (371,710 lbs/sq. in.) where the roof and side plates are in one piece and 23,398 kg/cm² (3,32,800 lbs/sq. in). when they are riveted,
C_1 = 0·08 cm (0·03 in.)
C_2 = 60·96 cm (24 in.)
C_3 = 0·875 kg/cm² (12·5 lbs/sq. in.) where the roof and side plates are in one piece and 0·73 kg/cm² (11·25 lbs/sq. in.) where they are riveted.

(143) In regulation 232, for equations (70) & (71) and entries below them the following equations and entries shall be substituted, namely :—

$$W.P. = \frac{C(t-C_1)}{R} \quad \text{.....Eqn. (70)}$$

$$W.P. = \frac{C_2(t^1 \times C_3)}{W} \quad \text{.....Eqn. (71)}$$

Where t is the thickness of roof plate before corrugations are formed,

t_1 is the thickness of side plates of firebox to which roof plate is attached,

R = the radius of transverse curvature or chamber of middle part of corrugation measured from the bottom of corrugation on waterside,

W = the widths of firebox measured over watersides of side plates at the seans attaching them to roof plate,

C = 540 kg/cm^2 (7,680 lbs/sq. in.)

C_1 = 0·24 cm (0·09 in.)

C_2 = 1969 kg/cm^2 (28,000 lbs/sq. in.)

C_3 = 0.08 cm (0·03 in.)

(144) In regulation 234,

(i) in clause (b), for the figures and abbreviation "2 inches", the figures abbreviations and brackets "51 mm (2 in.)" shall be substituted ;

(145) In regulation 240, for clauses (c), (d) and (e), the following clauses shall respectively be substituted, namely :—

(*c*) *Tensile Test* .—The ultimate tensile stress and minimum elongation shall be shown in Table below :—

ULTIMATE TENSILE STRESS AND MINIMUM ELONGATION FOR SEAMLESS FORGED DRUMS

Ultimate tensile stress		Minimum Elongation
Kg/mm^2	Tons/Sq. in.	Per cent
44—50	28—32	25
50—56	32—36	21
54—60	34—38	19

Should a tensile test piece break outside the middle half of the test gauge length the test may be discarded and another test be made of the same drum.

(*d*) *Bend test pieces.*—Bend test pieces shall be of rectangular section 25 mm (1 in.) wide by 19mm (¾ in.) thick. The edges shall be rounded to a radius of 1·6 mm (1/16 in.). The test pieces shall be bent over the thinner section.

(*e*) *Bend Tests.*—The test pieces shall , when cold, be capable of being bent without fracture, through an angle of 180°, the internal radius of the bend being not greater than that specified in table below :—

Ultimate tensile stress		Internal radius of bend	
Kg/mm^2	Tons sq. in.	mm	inch.
Upto 50	Upto 32	10	3/8
Above 50 & upto 56	Above 32 and upto 36	13	½
Above 56 & upto 60	Above 36 and upto 38	19	¾

(146) for regulation 246, the following Regulation shall be substituted, namely :—

246. *Steel Castings.*—Steel castings for pressure part shall comply with Regulations 73 to 80 [45 to 55 Kg/mm^2 (28-35 tons/sq. in)].

(147) in Regulation 255, for the figures and abbreviation "$\frac{1}{4}$ in.", the figures, abbreviation and brackets "30 mm ($\frac{1}{4}$ in.)" shall be substituted ;

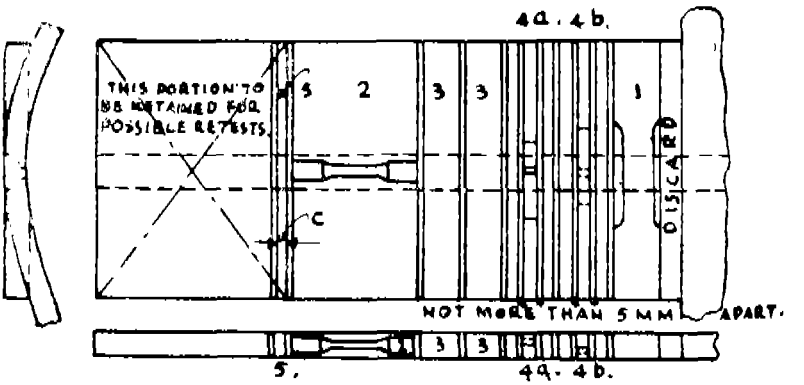
(148) For the table in regulation 256, the following table shall be substituted, namely :—

Nominal internal diameter of drum	Percentage of nominal internal diameter
Upto and including 914 mm (36 inches)	. . 0·375
Over 914 mm upto and including 1143 mm (45 inches) . .	. . 0·350
Over 1143 mm (45 inches)	. . 0·300

(149) in Regulation 258,—

(i) in clause (b), for the figures and abbreviation "1/32 in.", the figures, abbreviation and brackets "0·8 mm (1/32 in.)" shall be substituted ;

(ii) for the Figure 16 and Figure 17 and the entries below them, the following shall be substituted, namely :—

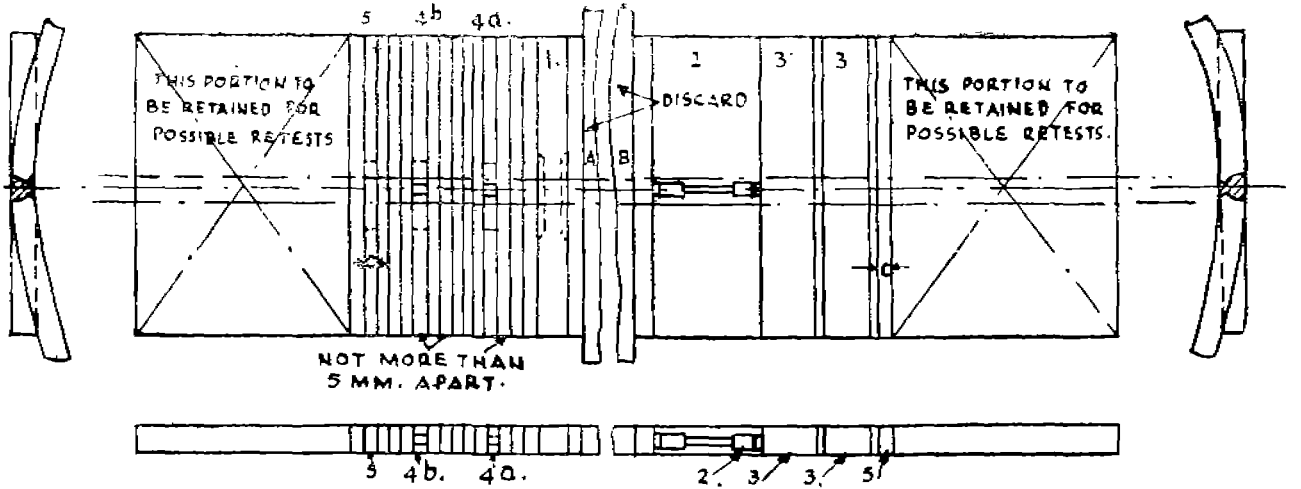


1. TENSILE TEST FOR JOINT
2. TENSILE TEST FOR ALL WELD METAL
3. BEND TEST OUTER AND INNER SURFACES OF PLATE (AT WELD)
4. a. IZOD IMPACT TEST, OUTER SURFACE OF PLATE
   b. IZOD IMPACT TEST, INNER SURFACE OF PLATE
5. MICRO AND MACRO SPECIMEN

WHERE C = 13 MM. (1/2 IN.).

DETAILS OF TEST PLATES

FIG. 16.



1. TENSILE TEST FOR JOINT
2. TENSILE TEST FOR ALL WELD METAL
3. BEND TEST OUTER AND INNER SURFACES OF PLATE (AT WELD)
4. a. IZOD IMPACT TEST, OUTER SURFACE OF PLATE.
   b. IZOD IMPACT TEST, INNER SURFACE OF PLATE.
5. MICRO AND MACRO SPECIMEN.

WHERE C = 13 MM. (1/2 IN.)

DETAILS OF TEST PLATES.

FIG. 17.

(150) in Regulation 259,—

(i) for the entries below Fig. 18, the following entries shall be substituted, namely :—

T=Thickness of plate.

b=Breadth of test piece :
Specimen 1.—Not less than T and in no case less than 38 mm (1½ in.)
Specimen 1a.—T × b not less than 967·74 mm² (1½ sq. in.)

W=Width of weld groove.

P=Parallel length, minimum=3 × W

r=Radius at shoulder, minimum=13mm (½in.)

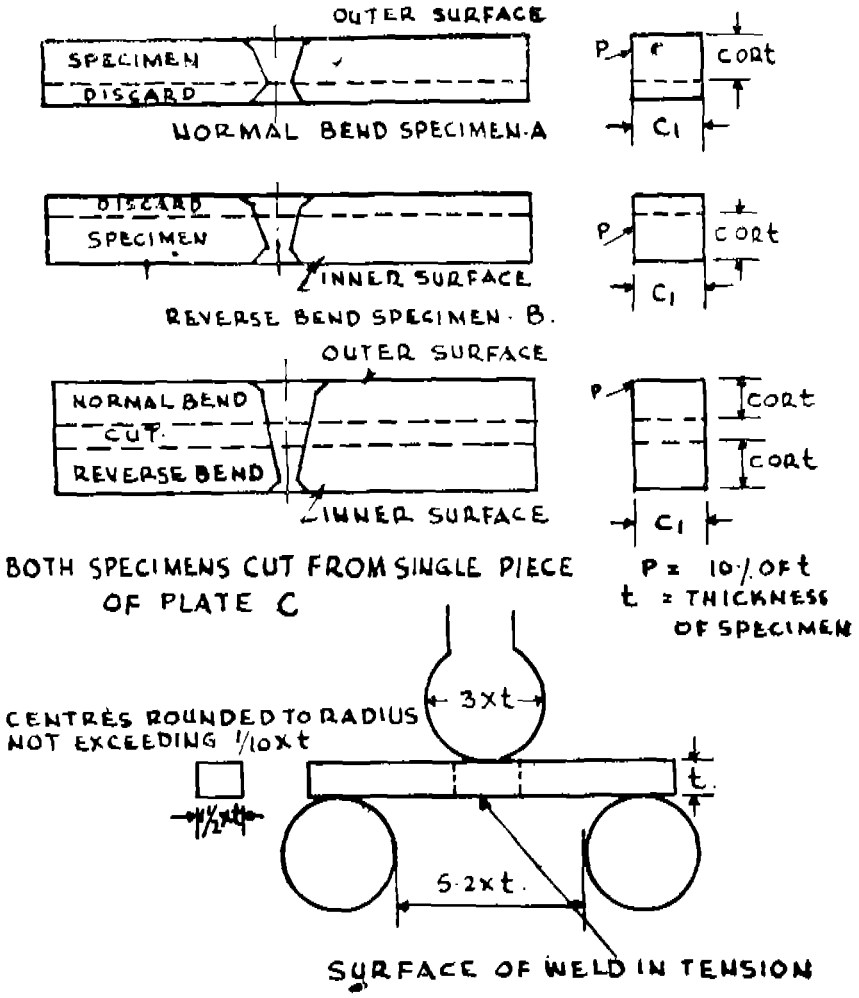
(ii) for the table under Fig. 19 the following table shall be substituted, namely :—

Diameter D		Cross-sectional area A		Gauge length G		Parallel length P minimum		Radius at shoulder R minimum	
mm	in.	mm²	sq. in.	mm	in.	mm	in.	mm	in.
20·27	0·798	322·60	0·50000	71·63	2·82	80·77	3·18	17·78	0·70
14·32	0.564	161·30	0·2500	51·00	2.00	57·15	2·25	12·7	0·50
12·83	0·505	129·04	0·20	45·47	1·79	51·05	2·01	11·43	0.45
12·17	0·479	116.13	0·18	43·18	1.70	5·57	1·91	10·67	0·42
11.48	0·452	103·23	0·16	40.64	1·60	45·72	1·80	10·16	0·40
11·10	0·437	96·77	0·15	39·37	1·55	44·20	1.74	9·91	0·39
10·76	0·424	91·09	0·1412	38.0	1·50	42·93	1·69	9·40	0·37
10·13	0·399	80·65	0·1250	35·81	1.41	40·13	1·58	8·89	0·35
9·07	0·357	64·52	0·1000	32·00	1·26	36·07	1.42	7·87	0·31

(151) in Regulation 261,—

(i) in clause (b), for the figures and abbreviations "1¼ in." wherever they occur, the figures and abbreviations "32 mm (1¼ in.)" shall be substituted ;

(ii) for Fig. 20, the following Figure shall be substituted, namely :—



SPECIMEN OF BEND TEST

WHERE C = 32 MM. (1¼ IN.)
C1 = 48 MM. (1⅞ IN.)

FIG. 20

(152) in Regulation 262, for the figures and abbreviations "1/16 in." and "1/8 in." the figures, abbreviations and brackets "1.6 mm (1/16 in.)" and "3 mm (1/8 in.)" shall respectively be substituted ;

(153) for Regulation 263, the following Regulation shall be substituted, namely,—

263. *Izod Impact Tests.*—The dimensions of the two specimens shall be in accordance with Fig. 21, specimens 4a and 4b.

One specimen shall have the notch cut at the middle of the outer surface of the weld and the other at the middle of the inner surface of the weld.

The tests shall show a minimum Izod impact test value of 2·77 kg. meters (20 ft. lbs.)

(154) in Regulation 264, in clause (c), for the figures and abbreviations "20 ft. lbs. ", the figures, abbreviations, word and brackets "277 kg. meters (20 ft. lbs.)" shall be substituted ;

(155) in Regulation 265, in clause (a), for the words "half-an-inch", the figures, abbreviation, brackets and word "13 mm (½ inch)" shall be substituted ;

(156) in Regulation 270,—

(*i*) for clauses (a), (b) and (c), the following clauses shall be substituted, namely:— [

270. *Shells of steam and water drums.*—(a) The working pressure shall be determined by the following formula:—

$$W.P. = \frac{2fE(T-C)}{D+(T-C)} \quad \text{.....Eqn. (72)}$$

Where T = Thickness
D = Maximum internal diameter
W.P. = Working pressure
f = Permissible working stress at working metal temperature (see reg. 271).
E = Efficiency of ligaments between tube holes or other openings in shell or of longitudinal joints (expressed as a fraction) whichever applies.
C = 0·08 cm (0·03 in.)

In the particular case of an unpierced wrapper plate of fusion welded drum E = 1 and f = permissible stress or butt weld from the table in Reg. 271, Column B.

(*b*) Irrespective of the thickness obtained by the use of the foregoing formula, "T" shall not be less than:—

(*i*) For tube plates (where the tubes are expanded therein) the thickness shall be at least such as to allow a minimum parallel belt width of tube seat of 10 mm (3/8 in.) this seating to be measured as explained below.

(*ii*) All tubes shall be carefully expanded into the holes in the tube plates. The tubes shall be belled or beaded to resist withdrawal and if belled they shall project through the parallel tube seat at least 6mm (1/4 in.)

(*c*) The Belling shall be as shown in the table below:—

TABLE

Outside diameter of tube	Amount of diameter of belling over diameter of the tube hole
Up to and including 38 mm (1-1/2 in.)	2·4 mm (3/32 in.)
Over 38 mm upto and including 51 mm (2 in.)	3·2 mm (4/32 in.)
Over 51 mm upto and including 82 mm (3-1/4 in.)	4·0 mm (5/32 in.)
Over 82 mm upto and including 102 mm (4 in.)	4·8 mm (6/32 in.)

(*ii*) in clause (d), for the figures and abbreviations "1/2 in." the figures, abbreviations and brackets "13mm (1/2 in.)" shall be substituted;

(*iii*) in clause (e), for the figures and abbreviation "3/8 in.", the figures, abbreviations and brackets "10 mm (3/8 in.)" shall be substituted;

(157) In Regulation 271,—

(*i*) in clause (a) and (b), for the figures, symbols and abbreviations "50°F", the figures, symbols, abbreviations and brackets "28°C(50°F)" shall be substituted;

(*ii*) in the Note, for the figures, symbol and abbreviations "700°F", the figures, symbols abbreviations and brackets "371°C (700°F)" shall be substituted;

(158) in Regulation 273, in clauses (a), (b) and (c), the words and brackets "in inches", "in square inches", "in (inches)", "in pounds inches" and "in pound per square inch" wherever they occur shall be omitted.

(159) in Regulation 275, for the figures and words "2-1/2 inches", the figures, abbreviations and brackets "64 mm (2-1/2 in.)" shall be substituted;

(160) for Regulation 277, the following Regulation shall be substituted, namely:—

277. *End plate with manhole*:—When an end plate has a flanged-in-manhole the depth of the flange forming the access opening measured from the outer surface of the plate at the minor axis of the opening shall be not less than:—

$$\sqrt{T \times W} \quad \text{.....Eqn. (73)}$$

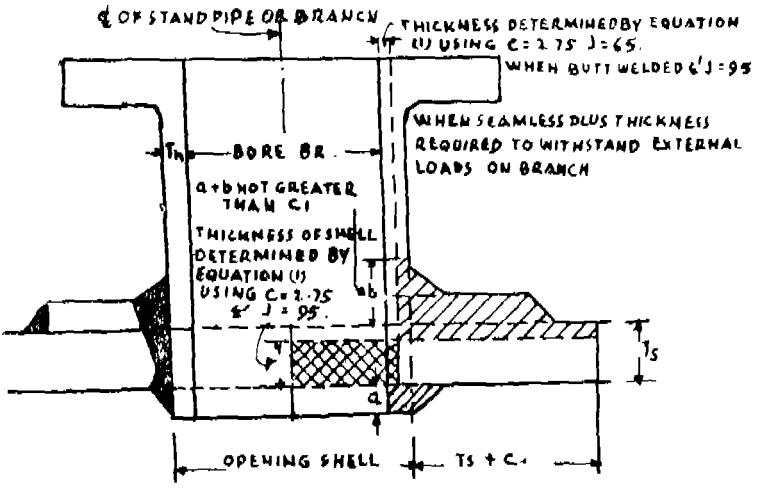
Where T = Thickness of end plate
W = Minor axis of the manhole

Note:—The corner radius of the manhole flange $\frac{r}{m}$ shall be not less than 25mm $\frac{r}{m}$ (in.) See fig. 23).

(161) in Regulation 279, in clause (a),—

(*i*) for the figures and abbreviations "4 in." and "3 in.", the figures, abbreviations and brackets "102mm (4 in.) " and "76 mm (3 in.)" shall respectively be substituted

(*ii*) for the Fig. 25B, the following Figure shall be substituted, namely:—



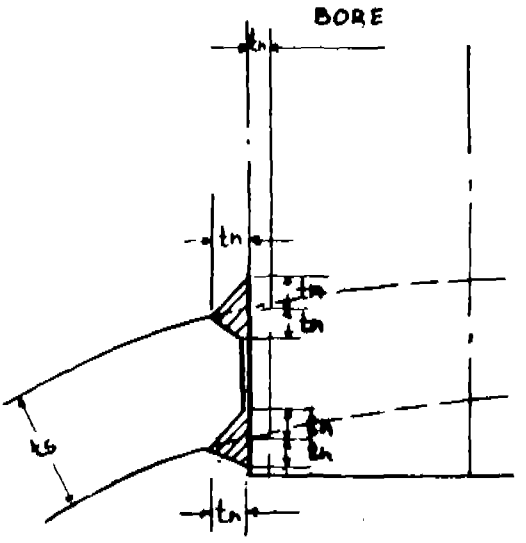
WHERE C = 76 MM. (3 IN)
C1 = 102 MM. (4 IN.)

NOTE:- AREA Y TO BE NOT LESS THAN AREA X

COMPENSATION FOR WELDED STANDPIPES, AREA TO BE COMPENSATED AND CORRESPONDING AREA ALLOWABLE FOR COMPENSATION

FIG 25 B.

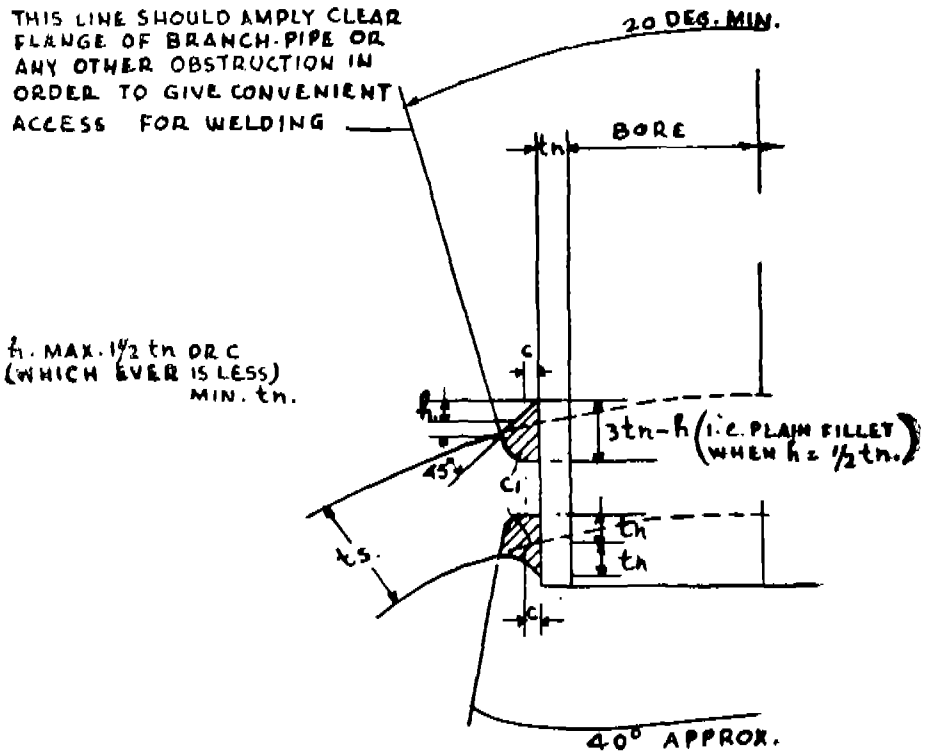
(*iii*) for the figs. 24-A, 24-B, 24-C, 24-D, -26-A, 26-B, 26-C, 26-D, 26-E, 27-A and 27-B the following Figures shall be substituted, namely:—



WELDED IN STANDPIPE OR BRANCH

FOR STANDPIPES AND BRANCHES UP TO AND INCLUDING 102 MM. (4IN.) BORE.

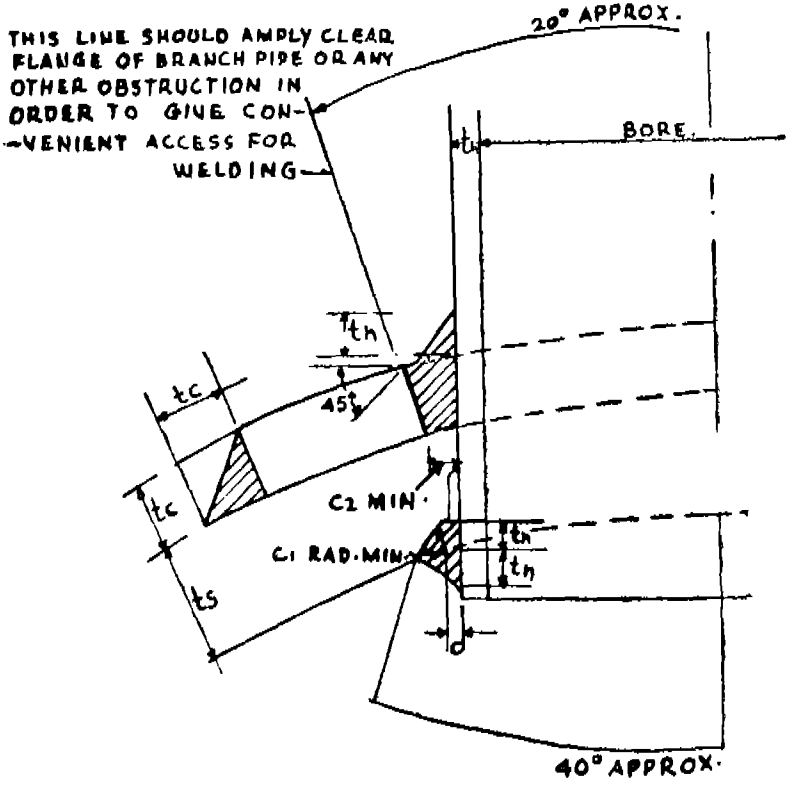
FIG. 24. A.



WHERE C = 3MM. (⅛IN.)
C1 = 6 MM. (¼IN.)

WELDED-IN STANDPIPES OR BRANCH FOR STAND PIPES OR BRANCHES UPTO AND INCLUDING 102 MM. (4IN.) BORE.

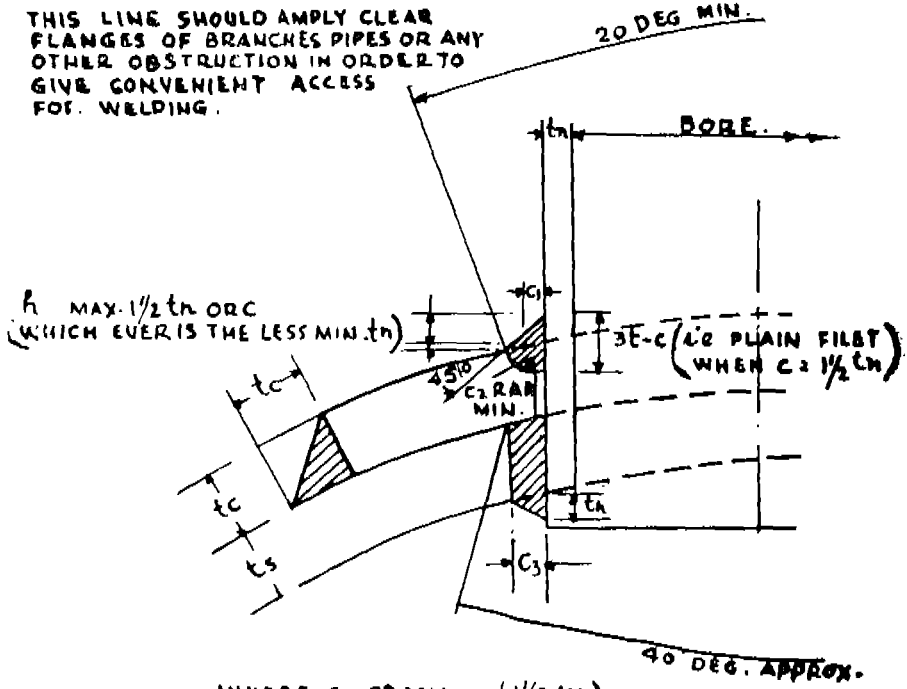
FIG. 24 B.



WHERE C = 3 MM. (1/8 IN.).
C1 = 6 MM. (1/4 IN.).
C2 = 8 MM. (5/16 IN.).

WELDED-IN STANDPIPE OR BRANCH WITH COMPENSATING RING FOR STANDPIPES OR BRANCHES UPTO AND INCLUDING 102 MM. OR (4 IN.) BORE

FIG. 24 C.

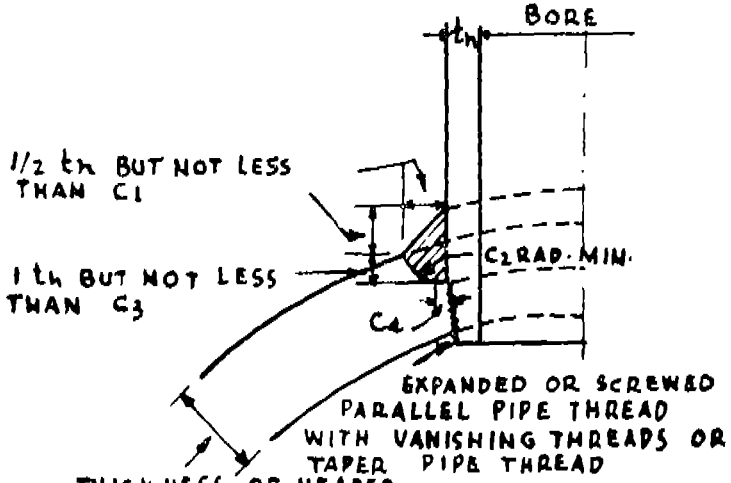


WHERE C = 29 MM (1⅛ IN.)
C1 = 3 MM (⅛ IN)
C2 = 6 MM (¼ IN)
C3 = 8 MM (5/16 IN.)

WELDED IN STANDPIPE OR BRANCH WITH COMPENSATING RING FOR STANDPIPES AND BRANCHES UPTO AND INCLUDING 102 MM. (4IN.) BORE

FIG. 24. D.

BORE OF BRANCH NOT GREATER THAN HALF INNER RADIUS OF HEADER, UPTO A MAX. OF 76 MM (3 IN.)



WHERE C_1 = 11 MM (7/16 IN.)
C_2 = 6 MM. (1/4 IN.)
C_3 = 10 MM. (3/8 IN.)
C_4 = 3 MM. (1/8 IN.)

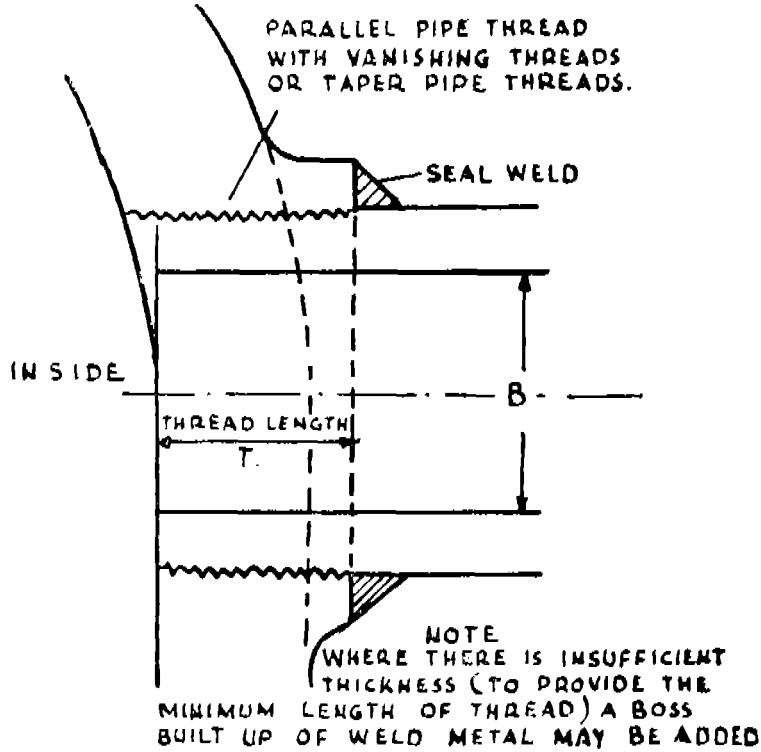
MAX. DESIGN PRESSURE 31.5 KG/CM^2 (450 LB SQ IN.)
MAX. DESIGN TEMPRATURE 288° C (550° F)

HEADER BRANCHES WELDING ACCESSIBLE FROM OUT SIDE ONLY.

APPLICABLE TO THE CIRCULAR SECTION OF HEADERS WITH ABOVE LIMITING SIZE OF BRANCH OR FLAT SIDES OF HEADERS WITHOUT LIMITING SIZE OF BRANCH.

NOTE:- THIS TYPE OF WELD IS NOT RECOMMENDED WHERE THE INSIDE OF THE HEADER IS ACCESSIBLE FOR WELDING.

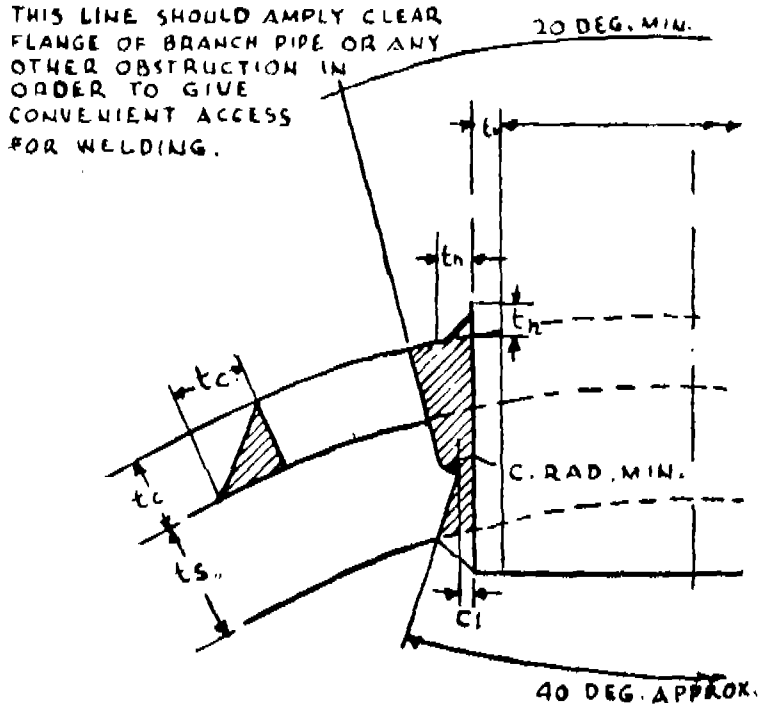
FIG. 26A.



NOMINAL BORE OF PIPE B	TOTAL LENGTH OF THREAD (MINIMUM) (T)
38 MM. AND 32 MM (1 1/2 IN AND 1 1/4 IN.)	25 MM. (1 IN.).
25 MM. (1 IN.)	22 MM (7/8 IN.)
19 MM. (3/4 IN.)	19 MM. (3/4 IN.)
13 MM. AND BELOW. (1/2 IN. AND BELOW)	16 MM. (5/8 IN.)

SCREWED AND SEAL WELDED CONNECTION.

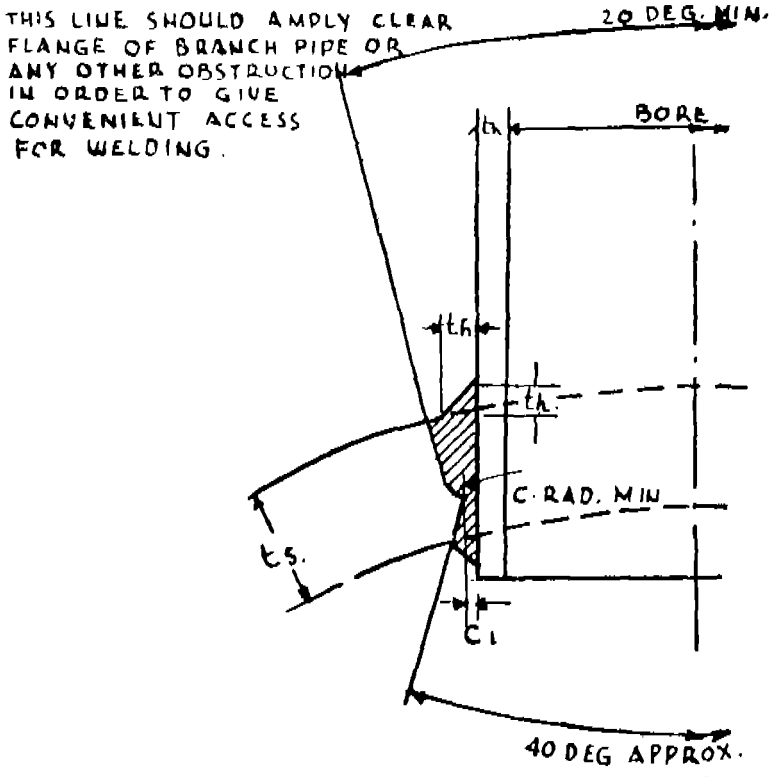
FIG. 26 B



WHERE C = 6 MM. (1/4 IN.)
C1 = 3 MM. (1/8 IN.)

WELDED IN STAND PIPE OR BRANCH WITH COMPENSATING RING.

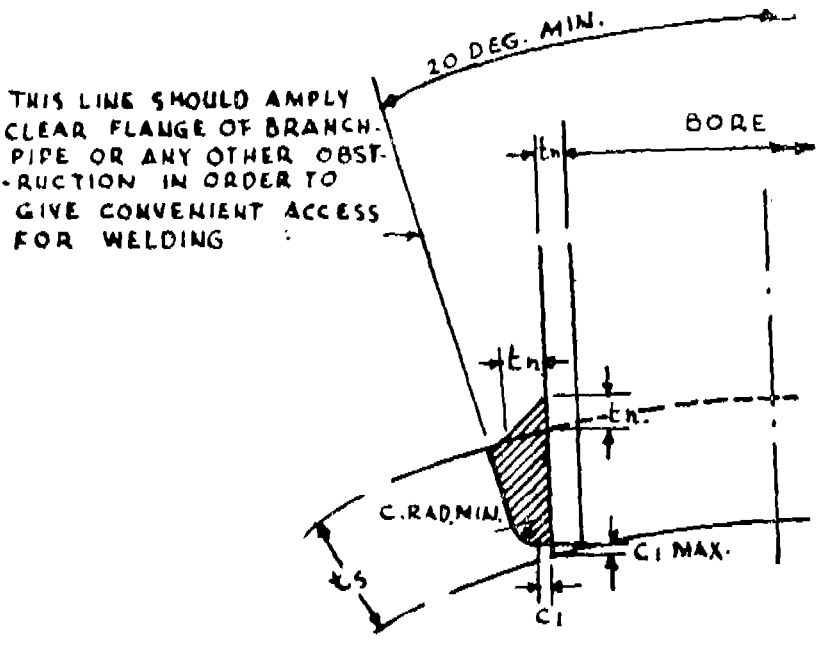
FIG. 26 C.



WHERE C = 6 MM. (1/4 IN.)
C1 = 3 MM. (1/8 IN.)

WELDED IN STANDPIPE OR BRANCH

FIG. 26.D



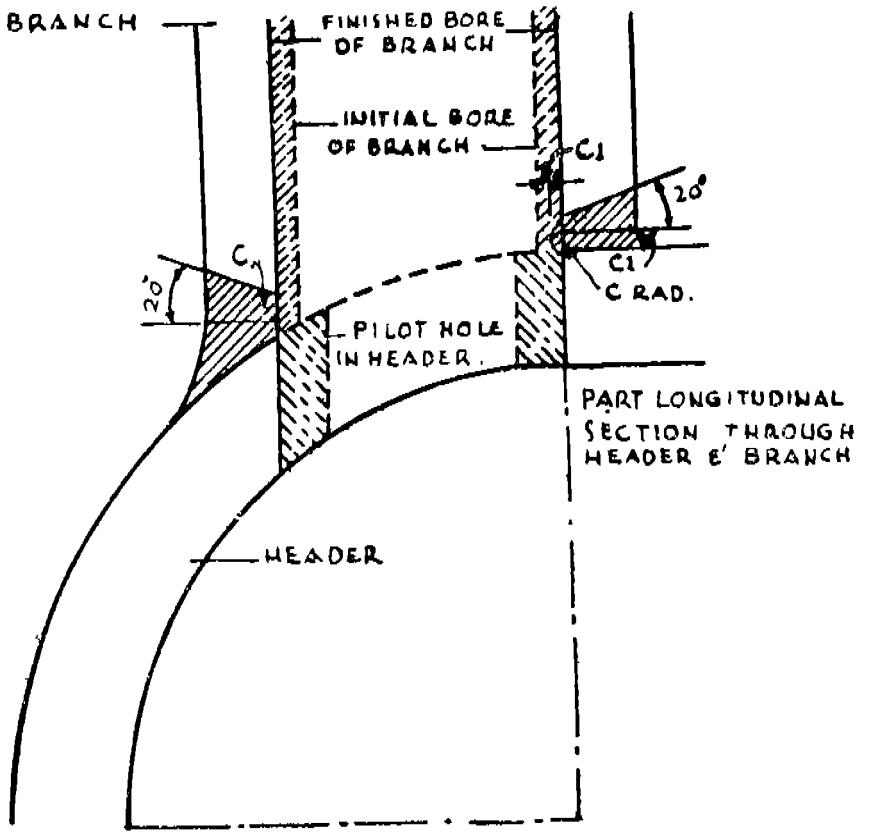
WHERE C = 6 MM. : (1/4 IN.),
C1 = 3 MM (1/8 IN.).

WELDED IN STAND PIPE OR BRANCH

THIS TYPE OF WELD IS NOT RECOMMENDED WHERE THE INSIDE OF HEADER OR DRUM IS ACCESSIBLE FOR WELDING.

(FIG. 26. E.)

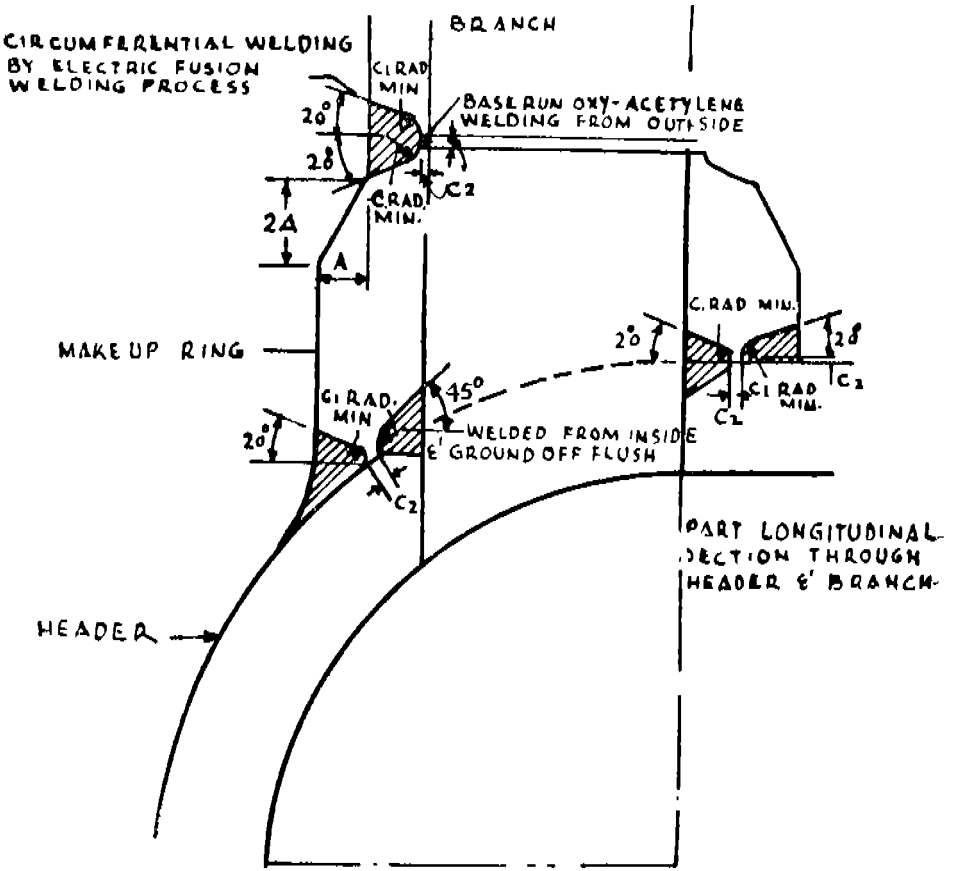
AMOUNT OF BRANCH BODY REMOVED BY MACHINING; MUST BE SUFFICIENT TO REMOVE BOTTOM PORTION OF WELD



WHERE · C = 6 MM. (1/4 IN.)
C1 = 3 MM (1/8 IN.)

BRANCH WELDED ON HEADER WITH INTERNAL MACHINING.

(FIG. 27A.)



WHERE C = 10 MM. (3/8 IN.).
C1 = 6 MM. (1/4 IN.).
C2 = 3 MM. (1/8 IN.).

BRANCH WITH MAKE-UP RING WELDED ON HEADER.

(FIG. 27. B)

(162) in Regulation 281, for the figures and abbreviations "3/4 in." and "200 sq. ft.", the figures, abbreviations, brackets and words "19 mm (3/4 in.)" and "18·8 square meters (200 sq. ft.)" shall respectively be substituted;

(163) in Regulation 282,—

(*i*) in clause (a), for sub-clauses (i) and (iv), the following sub-clauses shall respectively be substituted, namely:—

) Steel castings shall comply with 44 kg/mm² (28 tons per sq. in. Grade A) See regulations 73 to 80.

iv) Bronze castings shall have tensile breaking strength of not less than 25 kg/mm² (16 tons/sq. in.) with an elongation of not less than 8·0 per cent measured on standard test piece C.

(*ii*) for clauses (b) and (c), the following clauses shall be substituted, namely:—

(b) *Limits of Cast Iron.*—Cast iron shall not be used for:—

(*i*) Temperatures above 204°C (400°F)

(*ii*) Steam pressures exceeding 11·25 kg/cm² (160 lbs/sq. in.)

(*iii*) Feed valves and scum valves directly attached to boilers for pressures above 11·25 kg/cm² (160 lbs/sq. in.)

(*iv*) Blow down fittings.

(c) *Limits of Bronze fittings.*—Bronze shall not be used for steam temperature above 218° (425°F)

For clause (b) of regulation 283, the following clause shall be substituted, namely:—

(*b*) The body of a boiler mounting shall be connected to the boiler flange by a strong and stiff neck. In no case shall the thickness of the neck of bronze mounting be less than 5mm (3/16 inch) for size upto and including 19mm (3/4 inch) bore or 6mm (1/4 inch) for sizes over 19mm (3/4 inch) bore.

(164) in Regulation 284, for the words "one inch", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted;

(165) in clause (a) of Regulation 285, for the figures and words "1-1/2 inch" and "2-1/2 inch" the figures, abbreviations and brackets "38 mm (1-1/2 in.)" and "64 mm (2-1/2 in.)" shall respectively be substituted;

(166) in Regulation 290,—

(*i*) for clause (b), the following clause shall be substituted, namely:—

(*b*) Valves may be fabricated from seamless steel pipes for pressures not exceeding 17·5 kg/cm² (250 lbs/sq. in.) and temperatures not exceeding 427°C (800°F). The welding should conform to Regulation 125 and the valve chest shall be stress relieved after fabrication. Valves meant for use in pipe work may also be fabricated by welding from seamless steel pipes but no restriction as above regarding pressure and temperature shall apply to them provided the welding complies with all the relevant requirements of fusion welding such as stress relieving and radiographic inspection of the weld and the like prescribed in Chapter V of these regulations.

The working pressure of the valves shall be determined from equation 91 where 2 Se shall be substituted by 1·8S. The wall thickness shall not be less than 10 mm (3/8 in). The fabricated valves with their assembled fittings shall withstand satisfactorily a hydraulic test to the same pressure as will be applied to the drum during its registration.

(*ii*) in clause (*c*), for the entries below Equation (77) and for the Tables of Values* of C & X the following shall be substituted, namely:—

Table of values of C and X

Material of Casting	C	X
	kg/cm²	cm.
Cast iron, at least 15·75 kg/mm² Tensile strength	360	0·48
Bronze, at least 25 kg/mm² Tensile strength	394	0·3
Cast steel, 44-55 kg/mm² tensile strength		
For temperature upto 288°C	788	0·6
For temperature upto 316°C	709	0·6
For temperature upto 343°C	630	0·6
For temperature upto 371°C	596	0·6
For temperature upto 399°C	570	0·6
For temperature upto 427°C	531	0·6
For temperature upto 454°C	495	0·6
For temperature upto 482°C	346	0·6

Intermediate values may be interpolated.

Table of values of C and X

Material of casting	C	X
	Lbs/sq.in.	in.
Cast iron, at least 10 tons tensile strength	5120	0·1875
Bronze, at least 16 tons tensile strength	5600	0·125
Cast steel, 28/35 tons tensile strength		
For temperature upto 550°F	11200	0·25
For temperature upto 600°F	10080	0·25
For temperature upto 650°F	8960	0·25
For temperature upto 700°F	8480	0·25
For temperature upto 750°F	8064	0·25
For temperature upto 800°F	7552	0·25
For temperature upto 850°F	7040	0·25
For temperature upto 900°F	4928	0·25

Intermediate values may be interpolated.

(167) in Regulation 293,—

(*i*) in Equation (78), for the portion beginning with "Where A=.." and ending with "safety of the valve is set", the following portion shall be substituted :—

Where A=for ordinary and high lift safety valves, the aggregate area of the orifices through the seatings of the valves.

=for full lift safety valves the nett area through the seats after deducting the area of guides or other obstructions when the valves are fully lifted.

E=total peak load evaporation per hour (including evaporation from water walls steaming economiser, and other heating surface in direct communications with the boiler) for which the boiler is specified. In no case, however, shall the evaporation as calculated for the purpose, be based on less than 29 kg. per hour per sq. meter (6 lbs. per hour per sq. ft.) of heating surface (exclusive of superheater and non-steaming economiser).

P =absolute pressure to which the safety valve is set.

(*ii*) for clause (b), the following clause shall be substituted, namely :—

(*b*) *Superheated steam.*—If the valves have to pass superheated steam the area shall be determined in accordance with the following formula:—

$$As = A\sqrt{K_1} \quad \text{.....Eqn. (79)}$$

Where As = area for superheated steam

A = Area for saturated steam

T = degree of superheat

$$K_1 = \frac{1+CT}{1000}$$

C = 2·7 per degree centigrade

(1·5 per degree Fahrenheight.)

(168) in Regulation 295, for the figures, word and abbreviation "1¼ inch" and "10,000 lbs" the figures, abbreviations and brackets "32 mm (1¼ in.)" and "4536 kgs. (10,000 lbs.)" shall respectively be substituted ;

(169) in Regulation 298, the abbreviations "sq. in." shall be omitted wherever they occur;

(170) for Regulations 309 the following Regulation shall be substituted namely:—

(309) *Determination of working Pressure.*—The maximum working pressure to be allowed for steel springs of round, square or rectangular section shall be determined from the following formulae :—

(*a*) Round section—

$$W.P. = \frac{C_1 \times \pi d^3}{DAC} \quad \text{. . . . . Eqn. (80)}$$

(*b*) Square Section—

$$W.P. = \frac{C_2 \times d^3}{DACK} \quad \text{. . . . . Eqn. (81)}$$

(*c*) Rectangular Section—

$$W.P. = \frac{C_2\, B^3H^2}{DACK\,(3B\ 1.8H)} \quad \text{. . . . Enq. (82)}$$

$$K = \frac{\frac{D}{d} - 1}{\frac{D}{d} - 4} + \frac{.615}{\frac{D}{d}}$$

(In case of rectangular section substitute B for d)..Eqn. (83).

W.P. = Working pressure (set pressure).

A = Loading area of valve

d = diameter of round or side of square steel.

B = Breadth of wire (radial to spring axis).

H = Depth of wire (parallel to spring axis).

D = Mean diameter of coil.

$$C = \text{Constant} = \frac{L_1 + L_2}{L_1} \quad \text{. . . . Eqn. (84)}$$

C_1 = 703 kg/cm² (10,000 lbs./sq. in.)

C_1 = 703 kg/cm² (10,000 lbs./sq. in.)

C_2 = 2,343 kg/cm² (33,333 lbs./sq. in.).

C_3 = 11,249 kg/cm² (160,000 lbs./sq. in.)

L_1 = Initial compression or extension of the spring to give the required loading as defined in Regs. 292 and 304.

L_2 = The further compression or extension of the spring to give the lift as defined in Regs. 292 and 304.

Examples :—

C = 2 where compression or extension of spring to give the required loading is 1/4 diameter of valve.

C = 1·5 where compression or extension of spring to give the required loading is half diameter of valve.

C = 1·25 where compression or extension of spring to give the loading is full diameter of valve.

NOTE.—The above formulae are based on a maximum allowable safe stress on the section of the springs of 5,625 kg/cm² (80,000 lbs./sq. in.).

(171) For Regulations 312, the following regulation shall be substituted, namely :—

312. *Number of Effective Coils.*—The number of effective or free coils in a compression or extension spring shall be determined from the following formulae:—

(*i*) For Round or Square Wire

$$N = \frac{K \times C \times d^4}{S \times D^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eqn. (85)}$$

(*ii*) For Rectangular Wire :

$$N = \frac{C_1 B^3 H^3 k}{(B^3 + H^3) S D^3} \quad . \quad . \quad . \quad \text{Eqn. (86)}$$

Where N = Number of effective coils.

K = compression or extension at set pressure.

C = 1,01,368 kg/cm² (14, 41,792 lbs./sq. in.) for round, or 1,38,229 kg/cm (19,66,080 lbs./sq. in.) for square steel.

d = diameter or side of square steel.

S = load on spring at blow off pressure.

D = Mean diameter of coil.

B = Breadth of Wire.

H = Depth of wire.

C_1 = 3,04,104 kg/cm² (43,25,376 lbs./sq. in.)

(172) in Regulation 313, for the figures and abbreviation "1/16 in.", the figures, abbreviation and brackets "1·6 mm (1/16 in.)" shall be substituted ;

(173) in Regulation 320, for the figures, abbreviations and word "3 ft." and "10,000 lbs." and "2 inches" the figures , abbreviations and brackets "914 mm (3 ft.)", "4503 kgs. (10,000 lbs.)" and "51 mm (2 in.)" shall respectively be substituted ;

(174) in Regulation 323 , for the figures and words "1½ inch" and "½ inch", and the figures abbreviations, brackets and words "13 mm (½ inch)" and "19 mm (¾ inch)" shall respectively be substituted ;

(175) in Regulation 326, for the figure and word "1 inch", the figure, abbreviation, brackets and word "25 mm (1 inch)" shall be substituted ;

(176) in Regulation 327,—

(*i*) for clauses (a), (b) and (c), the following clauses shall be substituted, namely :—

327 *Dials.*—(*a*) For pressures upto and including 35 kg/cm² (500 lbs./sq. in) pressure gauge dials shall be graduated from zero to twice the pressure, as nearly as may be practicable.

(*b*) For pressures exceeding 35 kg/cm² (500 lbs./sq. in.) the range of graduation shall be from zero to one and a half times the maximum permissible workin; pressure, as nearly as may be practicable, but in no case shall the maximum graduation on the gauge be less than 70 kg/cm² (1000 lbs. /sq. in).

(*c*) The scale on the dial shall be clearly and permanently marked in the proper units.

(*ii*) in clause (e), for the figures and words "6 inches" and "4 inches", the figures, abbreviations, brackets and words "152 mm(6 inches)" and "102 mm (4 inches)" shall respectively be substituted ;

(177) in Regulation 330, for the second sentence, the following sentence shall be substituted namely :—

"The receiving sockets shall be tapped with a Standard screw thread to suit the Inspectors' gauge and shall be fit with easily removable cap."

(178) in the Note below Regulation 331, for the figures and words "12 inches to 18 inches", the figures abbreviations, bracket and word "305mm (12 inches) to 407 mm (18 inches)" shall be substituted ;

(179) in Regulation 332, for the first paragraph, the following paragraph shall be substituted, namely :—

332. *Type.* Fusible plugs shall consist of an outer body with a central coinical passage the smallest part to be not greater than 13mm (½ in.) for plugs suitable for pressure upto 7 kg/cm² (100 lbs./sq. in.) and not greater than 10mm (3/8 in.) for plugs for pressures exceeding 7 kg. cm² (100 lbs. sq. in.). The passage shall be closed by a plug secured by an annular lining of fusibl alloy so that the plug may drop clear if lining melts.

(180) in Regulation 333, for the gures, symbol and abbreviation "150°F", the figures symbols, and brackets "66°C (150°F)" shall be substituted ;

(188) in Regulation 334, for the second sentence, the following sentence shall be substiuted, namely:—

"The screwed portion shall have threads of a standard from having a pitch not less than 2·5 mm (0·091 inch)" ;

(181) in Regulation 335, in clause (c), for the figure and abbreviation "5 ft.", the figures, abbreviations and brackets "1524 mm (5 ft.)" shall be substituted ;

(182) in Regulation 341, for the portion " W.P. = ..." and ending with " utlimate tensile stress", the following portion shall be substituted, namely:—

$$W.P. = P_1 \times \frac{\text{Permissible stress at working metal temperature Eg 1. (90)}}{F \times C}$$

Where W.P. = The working pressure

P_1 = The maximum internal hydraulic pressure with stood without permanent deformation,

F = 1·75 for wrought steel and 2 for cast steel

C = 1090 kg/cm.² (15,500 lbs./sq. in) for wrought steel of 38 kg/mm² (24 tons/ sq. in) minimum ultimate tensile stress,

= 1160 kg/cm.² (16,500 lbs./sq. in.) for wrought steel of 41 kg/mm² (26 tons/ sq.in) minimum ultimate tensile stress,

= 1266 kg/cm² (18,000 lbs./sq. in) for wrought steel of 44 kg/mm.² (28 tons/ sq. in) minimum ultimate tensile stress,

= 1476 kg/cm.² (21,000 lbs./sq. in) for wrought steel of 50 kg/mm². 32 tons sq. in) minimum utltimate tensile stress,

= 1547 kg/cm.² (22,000 lbs./sq. in) for wrought steel of 54 kg/mm². 34 tons/ sq. in) minimum ultimate tensile stress,

= 1090 kg/cm.² (15,000 lbs/sq. in) for cast steel of 44 kg/mm².(28 tons/sq. in minimum ultimate tensile stress.

(183) in Regulation 344—

(*i*) for the figures, symbol and abbreviation " 750°F", the figures, symbols, abbreviations and brackets " 399° C (750°F)" shall be substituted;

(*ii*) for the Table 1 below clause (b), the following Table shall be substituted, namely:—

A. Tables under Reg. 344 (b) shall be substituted by the following table:—

TABLE I.

Kind of pipes	Ultimate tensile stress		Min. elongation per cent				Sulphur maximum %	Phosphorus maximum %
			on 203mm	(8 in.)	on 51mm	(2 in.)		
	Not less than	Not more than	6mm (1/4 in.) thick and over	Less than 6mm (1/4 in) thick	6mm (1/4 in.) thick and over	Less than mm (1/4 in) thick		
Cold-drawn Weldless Steel Pipes								
Strips cut from the pipes and tested in their curved condition.	36 kg/mm² (26 tons per sq. in.)	47 kg/mm² (30 tons per sq. in.)	20	18	32	30	0·5	0·5
Test lengths taken from finished pipes (ends to be plugged for grips.)	36 kg/mm² (23 tons per sq. in.)	47 kg/mm² (23 tons per sq. in.)	25	23	..	..		
Hot-finished Weldless Steel Pipes								
Strips cut from the pipes and tested in their curved conditions	36kg/mm² (23 tons per sq. in.)	47 kg/mm² (30 tons per sq. in).	20	18	32	30	0·05	0·05
Test lengths taken from finished pipes (ends plugged for grips.)	36 kg/mm² (23 tons per sq. in.)	47kg/mm² (30 tons per sq. in.)	25	23	..	..		

Roll Lapwelded Steel Pipes

Strips cut from the pipes clear of the welds & tested in their curved condition.	35 kg/mm² (22 tons per sq. in.)	44kg/mm² (28 tons per sq. in.)	20	18	32	30	0·6	0·6
Test lengths taken from finished pipes (ends to be plugged for grips)	35 kg/mm² (22 tons per sq. in.)	44 kg/mm² (28 tons per sq. in.)	25	23	..	..		

Hydraulic (Water gas) Lapwelded Steel Pipes.

	Ultimate tensile stress		Min. elongation percent on 203mm (8 in.)			Sulphur maximum %	Phosphorrus maximum %
	Not less than	Not more than	13mm (½ in.) thick & over	Less than 13mm (½ in.) thick & not less than 6mm (1/4 in.) thick	Less than 6mm (¼ in.) thick		
Selected Samples cut transversely	36kg/mm² (23 tons per sq. in.)	44kg/mm² (28 tons per sq. in.)	23	20	18	0·05	0·05

(184) in Regulation 346, for the figures, abbreviation and symbol "4 in. and 2 in. ", the figures abbreviations and brackets "102 mm (4 in.)" and "52 mm (2 in.)" shall respectively be substituted ;

(185) in Regulation 347, for the figures and symbol "1½ in." and "3/8 in." wherever they occur, the figures, abbreviations and brackets "38 mm (1½ in.)" and "10 mm (3/8 in.)" shall respectively be substituted ;

(186) in Regulation 350, for the Equation (91) and the entries below it, the following Equation and entries shall be substituted, namely :—

$$W.P. = \frac{2Se\ (t-c)}{D} \quad \ldots\ldots \text{Eqn. (91).}$$

Where t = Minimum thickness,

W.P. = Working pressure,

D = Outside diameter of pipes,

S = Allowable stress as specified in Table 3.

e = efficiency factor ;

= 1 for weldless steel pipes;

= 0·9 for welded steel or iron pipes for values of t upto and including 22mm (7/8 in.),

= 0·85 for welded steel pipes for values of t over 22mm (7/8 in.) and upto and including 29mm (1-1/8 in.),

= 0·8 for welded steel pipes for values of t over 29mm (1-1/8 in).

C = 0·1 cm (0·04 in.).

(187) for Regulation 351, the following Regulation shall be substituted, namely :—

351. *Cast steel pipes.*—(*a*) The material shall comply with Regulations 73 to 80 i.e. 44 kg/mm² (28 tons) minimum tensile stress.

(*b*) The maximum working pressure allowed on cast steel pipes shall be determined by the following formula :—

$$W.P. = \frac{2S\ (t - \cdot 015D - C)}{D} \quad \ldots\ldots \text{Eqn. (92)}$$

Where t = minimum thickness

W.P. = Working Pressure

D = External diameter of pipe.

S = Allowable working stress as specified in table (4.)

C = 0·064 cm (0·25 in.)

(188) In regulation 352 (*i*) for clauses (*b*) & (*d*) the following clauses shall be substituted namely :—

(*b*) Copper pipes may be used for a working pressure not exceeding 12·7 kg/cm² (180 lbs/sq. in). The external diameter shall not exceed 127 mm (5 in.)

(*d*) The maximum working pressure on such pipes shall be determined by the following formula :—

$$W.P. = \frac{C\ (t - C_1)}{D} \quad \ldots\ldots \text{Eqn. (93)}$$

Where t = Minimum thickness.

W.P. = Working Pressure.

D = Outside diameter of pipe.

C = 352 kg/cm² (5,000 lbs/sq. in.)

C_1 = 0·08 cm (0·03 in.)

(ii) for table 2,3 and 4, the following Tables shall be substituted, namely:—

TABLE 2.—*Maximum permissible Working Pressure and Temperature*

Material	Method of manufacture	Maximum permissible pressure	Maximum permissible temperature	Form
Mild steel . .	Cold drawn weldless	No restrictions	482°C (900°F)	Straights, bends or tees, etc.
	Hot finished weldless.	Do.	482°C (900°F)	
	Hydraulic water gas lap-welded.	Do.	482°C (900°F)	Do.
	Roll lap-welded	21kg/cm² (300 lbs/sq. in.)	260°C (500°F)	Do.
Wrought iron . .	Roll lap-welded	17·5 kg/cm² (250 lbs/sq. in).	218°C (425°F)	Straights, bends or tees, etc.
Cast steel . .	Castings	No restriction	482°C (900°F)	Straights, bends or tees, etc.
Copper .	Solid drawn	Upto and including 127mm (5 in.) & 12·7 kg/cm² (180 lbs/sq. in.)	..	Straights and bends.

TABLE 3

Allowable working stress for design temperatures as given below

Intermediate values by linear interpolation.

	Upto and including									
	260°C (500°F)	288°C (550°F)	316°C (600°F)	343°C (650°F)	371°C (700°F)	399°C (750°F)	427°C (800°F)	454°C (850°F)	468°C (875°F)	482C (900°F)
Cold drawn weldless steel .	914 kg/cm². (13000 lbs/sq. in.)	879kg/cm². (12500 lbs/sq. in.)	830kg/cm². (11800 lbs/sq. in.)	780kg/cm². (11100 lbs/sq. in.)	724kg/cm². (10300 lbs/sq. in.)	668 kg/cm². (9500 lbs/sq. in.)	598kg/cm². (8500 lbs/sq. in.)	527kg/cm². (7500 lbs/sq. in.)	478kg/cm². (6800 lbs/sq. in.)	397kg/cm². (5600 lbs/sq. in.)
Hot-finished weldless steel . Hydraulic (water gas) lap-welded steel										
Roll lap-welded steel . .	865 kg/cm² (12300 lbs/sq. in.)	Not used for these temperatures.								

TABLE 4.—*Maximum permissible working stress for cast steel*
(Values of S)

Permissible working stress for design temperature								
Over								
288°C (550°F)	316°C (600°F)	343°C (650°F)	371°C (700°F)	399°C (750°F)	427°C (800°F)	454°C (850°F)	468°C (875°F)	
Upto and including								
288°C (550°F)	316°C (600°F)	343°C (650°F)	371°C (700°F)	399°C (750°F)	427°C (800°F)	454°C (850°F)	468°C (875°F)	482°C (900°F)
703 kg/cm² (10,000 lbs/sq. in.)	633 kg/cm² (9000 lbs/sq. in.)	562 kg/cm² (8000 lbs/sq. in.)	532 kg/cm² (7560 lbs/sq in.)	506 kg/cm² (7200 lbs/sq. in.)	475 kg/cm² (6750 lbs/sq. in.)	443 kg/cm² (6300 lbs/sq. in.)	371 kg/cm² (5280 lbs/sq. in.)	309 kg/cm² (4400 lbs/sq. in.)

(189) *In Regulation* 353,—

(*i*) in clause (*a*), the table for the Carbon Steel for Flanges, shall be replaced by the following table, namely :—

Flanges in accordance with Appendix E	Tensile Strength		Minimum elongation on test piece C Per cent.	Sulphur (max) Per cent.	Phosphorus (max) Per cent.
	Kg/mm²	Tons/Sq.in.			
TABLES D to J inclusive.	36·47	23·30	Not less than C divided by tensile strength	0·06	0·06
TABLES K to T inclusive	41·50	26·32	..	0·05	0·05

Where C-1102 Kg/mm² *or* 700 tons/in.²

(*ii*) In clause (*b*) for the tables for chemical composition and maximum permissible working stress for alloy steel flanges the following tables shall be substituted namely :—

The material of alloy steel flanges shall comply with the requirements specified in the table below :—

ALLOY STEEL FLANGES

Classification	Carbon % Max.	Silicon % Max.	Sulphur % Max.	Phosphorus % Max.	Maganese % Max.	Molyb-denum % Max.	Chromium % Max.	Ultimate tensile stress minimum	Percentage elongation on gauge length of $4\sqrt{A}$ % Max.
Carbo n Molybdenum Steel	0·30	0·35	0·04	0·04	0·75	0·65	..	49 kg/mm² (31 tons/sq. in.)	Not less than C divided by tensile strength.
Chromium Molybdenum Steel. :—									
Grade I . .	0·20	0·40	0·04	0·04	0·75	0·65	0·10	49 kg/mm² (31 tons/sq. in.)	Not less than C divided by tensile strength.
Grade II . .	0·15	0·50	0·04	0 04	0·60	1·00	2·25	49 kg/mm² (31 tons/sq. in.)	Not less than C divided by tensile strength.

Where C = 1102 kg/mm² *or* 700 tons/in².

The materials for flanges should be similar to those of the pipes to which they are to be attached.

The flanges are to be so designed that the total stress induced in them does not exceed the maximum permissible stress shown in the table below :—

MAXIMUM PERMISSIBLE WORKING STRESS FOR ALLOY STEEL FLANGES

Classification	Upto & including 316°C (600°F)	343°C (650°F)	371°C (700°F)	399°C (750°F)	427°C (800°F)	454°C (850°F)	482°C (900°F)	510°C (950°F)	538°C (1000°F)	566°C (1050°F)	593°C (1100°F)	621°C (1150°F)	649°C (1200°F)
Carbon Molybdenum Steel	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1188 kg/cm² (16900 lbs/sq. in.)	1055 kg/cm² (15000 lbs/sq. in.)	..	..	..	..	..	..	...
Chromium Molybdenum Steel : Grade I	1230 kg/cm² (17500 lbs./sq. in.)	1181 kg/cm² (16800 lbs/sq. in.)	1135 kg/cm² (16150 lbs/sq. in.)	1090 kg/cm² (15500 lbs/sq. in.)	1044 kg/cm² (14850 lbs/sq. in.)	998 kg/cm² (14200 lbs/sq. in.)	921 kg/cm² (13100 lbs/sq. in.)	773 kg/cm² (11000 lbs/sq. in.)	527 kg/cm² (7500 lbs/sq. in.)	352 kg /cm² (5000 lbs/sq. in.)	lbs/sq. in.)	..	..
Grade II	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1230 kg/cm² (17500 lbs/sq. in.)	1125 kg/cm² (16000 lbs/sq. in.)	984 kg/cm² (14000 lbs/sq. in.)	773 kg/cm² (11000 lbs/sq. in.)	548 kg/cm² (7800 lbs/sq. in.)	408 kg/cm² (5800 lbs/sq. in.)	295 kg/cm² (4200 lbs/sq. in.)	211 kg/cm² (3000 lbs/sq. in.)	141 kg/cm² (2000 lbs/sq. in.)

Stress values for intermediate temperatures may be determined by linear interpolation.

(190) *For* Regulation 354, the following Regulation shall be substituted, namely:—

354. *Screwed on flange.*—The pipes may be screwed into flanges with a disappearing thread and expanded. Such screwed and expanded flanges may be used for steam for a maximum pressure of 31·5 kg/cm² (450 lbs./ sq. in) and/or a maximum temperature of 399° C (750°F) and for feed pipes for pressure upto 42·0 kg/cm² (600 lbs/sq. in.) Screwed and expanded flanges may in addition be seal welded.

(191) In Regulation 356, for clauses (a), (b), (c) ad (d), the following clauses shall be substituted, namely:—

356. *Riveted on flanges.*—(*a*) Riveted on flanges shall only be used for pipes of 178 mm (7 in.) bore and above and for a maximum pressure of 24·5 kg/cm². (350 lbs/sq. in.) and/or a maximum temperature of 399°C (750°F).

(*b*) The shear stress in the rivets shall not exceed 422 kg/cm² (6000 lbs/sq. in.) when calculated by the following formula :—

$$Sr = \frac{(A_o \times P)}{(AN)} \quad \text{.....Eqn. (94)}$$

Where Sr = the shear stress in the rivets.
A_o = Cross sectional area, calculated on outside diameter of pipe.
P = Working pressure.
N = Number of rivets.
A = Areas of one rivet hole.

(*c*) The stress in the pipe shall not exceed that specified in Table 3 when calculated by the following formula:—

$$Sp = \frac{(A_o \times P)}{(A_o - A_1) - (N \times d \times t)} \quad \text{.....Eqn. (95)}$$

Where Sp = the stress in the pipe,
A_o, P and N have the values given above and
A_1 = Cross sectional area, calculated on inside diameter of pipe,
d = diameter of rivet hole,
t = minimum thickness of pipe.

(*d*) The flange hub thickness shall not be less than 5mm (0·2 in.) thicker than the minimum thickness of pipe.

(192) In Regulation 357,—

(*i*) In clause (b), for the figures, abbreviations and symbol "250lbs.", "700°F", "150 lbs." and "500°F", the figures, abbreviations, brackets "17·5 kg/cm² (250 lbs./sq. in.)" "371°C (700°F)", "10·5 kg./cm² (150 lbs/sq. in.)" and "260°C (500°F)' shall respectively be substituted;

(*ii*) In clause (c), in sub-clause (iii) for figures, symbol and abbreviation "700°F", figures, abbreviations and brackets "371°C (700°F)" shall be substituted;

(*iii*) In clause (d), for the figures and symbol "12"", the figures, abbreviation and brackets "305 mm (12 in.)" shall be substituted;

(*iv*) For the tables below Figures 28 and 29 and for the tables by the side of Figures 30 and 31 including the heading for figures 30 and 31 and for the table below Figure 32, the following tables shall respectively be substituted, namely:—

A	t but not less than 6 mm (1/4 in.) and not more than 19 mm (3/4 in.)
B	t
C	t but not less than 10 mm (3/8 in.)
D	1½ t but not less than 10mm (3/8 in.)
E	1½ t but not less than 10 mm (3/8 in.)
F	t but not less than 10 mm (3/8 in.) and not more than 19mm (3/4 in.)
G	t but not less than 6 mm (1/4 in.)

A	1/2 t but not less than 5 mm (3/16 in.)
B	6 mm (1/4 in.) Min. for Tubes upto and including 8mm (5/16 in.) thick. t—1·6 mm (1/16 in.) for Tubes over 8 mm (5/16 in.) thick and upto and including 14·5 mm (9/16 in.) t—3 mm (1/8 in.) for Tubes over 14·5 mm (9/16 in.) thick and upto and including 22 mm (7/8 in.) t—6 mm (1/4 in.) for Tubes over 22 mm (7/8 in.) thick and upto and including 25 mm (1 in.)
C	t but not less than 10 mm (3/8 in.)
D	1½ t but not less than 10 mm (3/8 in.)
E	1½ t but not less than 10 mm (3/8 in.)
F	t but not less than 10 mm (3/8 in.) and not more than 19 mm (3/4 in.)
G	t but not less than 6 mm (1/4 in.)
A	1½ t but not less than 10 mm (3/8 in.)
B	1½ t but not less than 10 mm (3/8 in.)
C	t
D	t but not less than 6 mm (1/4 in.)

Fig. 30.—*For pressure conditions upto* 17·5 *kg/cm*^{2}. (250 *lbs./sq.in*) *& temperatures not exceeding* 371°*C* (700°*F*).

314. For the table by the side of fig. 31, the following table shall be substituted, namely:—

A	1/4 t but not less than 1·6 mm (1/16 in.)
B	2 t
C	t
D	t

Fig. 30.—*For pressure conditions upto* 10·5 *kg/cm*^{2} (150 *lbs/sq. in.*) *and temperatures not exceeding* 260°*C* (500°*F*).

A	t+1·6 mm (1/16 in.)
B	1·6 mm (1/16 in.) min.
G	1·6 mm (1/16 in.) min.

Where t is greater than 13 mm (1/2 in.) "U" sahaped groove as shown may be used.

A	15° min.
r	3 mm (1/8 in.)
h	3 mm (1/8 in.) max.
g	3 mm (1/8 in.) min. 6 mm (1/4 in.) max.
B	1·6 mm (1/16 in.) min.

(193) in clause (b) of Regulation 360, the following clause shall be substituted, namely:—

" (*b*) All steam pipes with butt welded circumferential joints having a wall thickness of 10 mm (3/8 in.) and above and carrying a pressure of over 3·5 kg/cm² (150 lbs. sq. in.) shall be effectively stress releived."

(194) for clause (a) of Regulation 361, the following clause shall be substituted, namely:—

361. *Wrought Bends.*—Wherever practicable the radii of bends (on centre line) shall be not less than those given below:—

Bore upto and including 152 mm (6 in.)	R=3·0d
Bore over 152 mm (6 in.) upto and including 229 mm (9 in.) . . .	R=3·5d
Bore over 229 mm (9 in.) upto and including 305 mm (12 in.) . . .	R=4·0d
Bore over 305 mm (12 in.) upto and including 381 mm (15 in.) . .	R=4·5d
Bore over 381 mm (15 in.) upto and including 457 mm (18 in.) . .	R=5·0d
Bore over 457 mm (18 in.) upto and including 508 mm (20 in.) . .	R=5·5d

Where d=the bore of the pipe,
R=Radius of bend to the centre line of pipe.

(195) for Regulation 362, the following Regulation shall be substituted, namely:—

362. *Branches, Tees, etc.*—Branches, bosses and drain pockets, shall be welded to the pipes. Where a branch is of equal size of to the main pipes, reinforcement as shown in Fig. 32A shall be employed. For pressures over 24·5 kg/cm² (350 lbs/sq. in) and/or temperatures of 399°C (750°F) or over branches of 152 mm (6 in.) bore and larger shall be welded inside as well as outside. Alternatively to the welding on the inside of the pipe, reinforcement as shown in Fig. 32A or mechanical locks shall be provided. The reinforcement shall be of substantial strength.

(196) in Regulation 364, for the figures, abbreviations and symbol " 160 lbs. per sq. in." and "400°F" wherever they occur, the figures, abbreviations, brackets and symbols " 11·2 kg/cm² (160 lbs. sq. in.)" and " 204°C (400°)F)" shall respectively be substituted.

(197) in Regulation 365,

(*i*) *in clause* (*b*) (**2**)

(*i*) in sub-clause (ii) for the figure and abbreviation 24 ins., the following, figures, abbreviations and brackets shall be substituted, namely:—

" 61 cm. (24 in.)"

(*ii*) in sub clause (iii) for the figures, words and abbreviations " 1 1/2", " 36 ins.", " 1 in." " 400 lbs/sq. in." and " 750°F" the following figures, abbreviations, words and brackets shall respectively be substituted, namely:—

" 38mm (1 1/2 in.)

91 cm (36 in.)

25 mm (1 in.)

28 kg/cm² (400 lbs/sq. in.)

399°C (750°F)"

(*i*) *in clause* (*b*) (3)

(*ii*) For the figures and abbreviations 3/16", 5/16", and 3/8" appearing in the table below Fig. 365/2, the following figures, abbreviations and brackets shall be substituted, namely:—

" 4·8 mm (3/16")

8 mm (5/16")

10 mm (3/8")"

For the figure and abbreviation 1/16" appearing in the table below Fig. 365/3, the following figures, abbreviations and brackets shall be substituted, namely:—

" 1·6 mm (1/16")"

(*ii*) In clause (c), for the figures, words and abbreviations 3/32", 1/8", 1/4", 5/16", 3/8", 1/2", 5/8", 3/4", 1", 1-1/8", 1-1/2", 4", 5", 6", 7", 9", 10", 12", 15", 18", 24 inches, 340°F, 500°F, 650°F, 105 lbs./sq. in., 150 lbs/sq. in., 200 lbs/sq. in., whenever they occur, the following figures, words, abbreviations and brackets shall respectively be substituted, namely:—

"2·4mm (3/32")

3 mm (1/8")

5 mm (3/16")

6 mm (1/4")
8 mm (5/16")
10 mm (3/8")
13 mm (1/2")
16 mm (5/8")
19 mm (3/4")
25 mm (1")
28 mm (1-1/8")
38 mm (1-1/2")
102 mm (4")
127 mm (5")
152 mm (6")
178 mm (7")
229 mm (9")
254 mm (10")
305 mm (12")
381 mm (15")
457 mm (18")
61 cm. (24 inches)
171°C (340°F)
260°C (500°F)
343°C (650°F)
7·3 kg/cm.² (105 lbs/sq. in.)
10·5 kg/cm.² (150 lbs/sq. in.)
14 kg/cm.² (200 lbs./sq. in.)"

(iii) In clause (f), sub-clause (1) shall be substituted by the following, namely:—

" (1) Rivetted Shells.—Preparation of Plates, butt straps, rivet holes and riveting shall comply with the relevant Regulations of Chapter III.

Longitudinal joints of rivetted shells may be lap jointed or fitted with double butt straps but in cases where the design pressure exceeds 9·14 kg/cm.² (130 lbs/sq. in) or the product of the design pressure and maximum internal diameter exceeds the value of C where C= 1696 where the pressure is in kg/cm² and the diameter is in centimeters (9500 where the pressure is in lbs./sq. in., and the diameter is in inches, the longitudinal joints shall be butt jointed with double cover straps. The design of revetted joints shall be in accordance with Regulations 177 to 184."

(iv) The second para of sub-clause (2) shall be substituted by the following, namely:—

" Clause I.—All shells designed for a pressure exceeding 35·15kg/cm² (500 lbs./sq. in) or shells of which the product of the designed pressure and the internal diameter exceeds the value of C where C=3750 where the pressure is in kg/cm² and the diameter in centimeters (21000 when the pressure is in lbs/sq. in and the diameter in inches) or the designed temperature exceeds 343°C (650°F).

(198) In Regulation 366,

(i) Clause (a) shall be substituted by the following :—

" *(a)* SHELLS

The maximum working pressure of shells shall be determined by the following formula:—

$$W.P. = \frac{2fE(T-C)}{D+(T-C)}$$

Where T is Thickness
D is maximum internal diameter
WP is working pressure.
f is permissible working stress at the working metal temperature.
E is Efficiency of longitudinal rivetted seam as given in Regulation 177.
is Efficiency factor for fusion welded shells as given in table below.

is 1·00 for seamless shells or shells made from seamless tubes.
is Efficiency of ligaments between holes or openings in shell, expressed as a fraction.
C is 0·08 mm (0·03 in.)

Class	Efficiency factor E
I	0·90
II	0·75 if welded from both sides. 0·50 if welded from one side only.

Minimum thickness of shells shall be as given in table below :

Classification	Internal diameter	Minimum thickness
Fusion welded Class I		6 mm (1/4 in.)
Fusion welded Class II, and shells other than fusion welded shells.	Upto and including 61 cm(24 in.)	6 mm (1/4 in.)
	Over 61 cm (24 in.) and upto and including 91 cm (36 in.)	8 mm (5/16 in.)
	Over 91 cm (36 in.)	10 mm (3/8 in.)

The maximum permissible stresses for cylindrical parts of seamless, fusion welded and rivetted shells shall not exceed those given below :—

Design temperature		Tensile Strength 44-50 kg mm²	28-32 tons/sq.	Tensile Strength 50-56 kg mm²	32-36 tons/sq.in	Tensile Strength 54-60 kg/mm²	34-38 tons/sq. in
		Seamless, fusion welded or rivetted shells		Seamless shells		Seamless shells	
°F	°C	Kg/cm²	lbs/sq.in.	Kg/cm²	lbs/sq. in.	Kg./cm²	lbs/sq. in.
Upto 650	343	1104	15,700	1266	18,000	1336	19,000
700	371	1069	15,200	1209	17,200	1280	18,200
750	399	942	13,400	1041	14,800	1090	15,500
800	427	794	11,300	851	12,100	879	12,500
850	454	626	8,900	654	9,300	668	9,500
900	482	443	6,300	443	6,300	443	6,300

Intermediate values may be obtained by linear interpolation.

Where steels are intended for service at temperature in excess of 371°C (700° F) this shall be so stated and silicon contents shall be not less than 0·10 per cent or alternatively the material Proof test for creep quality of carbon steel plate of boiler plate quality as in Appendix 'D'.

The maximum permissible stress (f) for shells made from weldelss pipes shall be those as given in table below :

Design temperature			Cold drawn or Hot-finished weldless steel.	
	°C	°F	kg/cm²	lbs/sq. in
upto	260	500	914	13,000
	288	550	879	12,500
	316	600	830	11,800
	343	650	780	11,100
	371	700	724	10,300
	399	750	668	9,500
	427	800	598	8,500
	454	850	527	7,500
	468	875	478	6,800
	482	900	394	5,600

Intermediate values may be obtained by linear interpolation.

The suitability of circumferential seams of riveted shells including the seams joining the ends of the cylinderical parts of the shell shall be verified by the following formula :—

$$W.P. = \frac{Ef\ (T - C_1)}{CD}$$

Where E = Joint efficiency expressed as a fraction calculated by formulae in Regulation 177

W.P. = Working Pressure.

D = Inside diameter of the outer strake of plating of the cylinderical shell.

T = Thickness of the plate.

f = Maximum permissible working stress at the working metal temperature given in column 1 of the table of stress in sub-regulation (*a*) above.

C = 0·257 where the seams are made with lap joints and treble riveted.
= 0·264 where the seams are made with lap joints and are double riveted.
= 0·300 where the seams are made with lap joints and are single riveted.

C_1 = 0·16 cm (0·06 in.)

Compensation for openings in shells.—Where the major axis or diameter of any hole cut in cylindrical parts of the shells is greater than 2½ times the thickness of the shell plate plus 70 mm (2 3/4 inches) compensation shall be provided.

The sectional area to be compensated measured in the plane parallel, to the logitudinal axis of the shell, which makes this area a maximum shall be the product of the length of the opening (including any rivet holes in the plane) and the thickness of a seamless shell of similar material calculated in accordance with Equation 72 (Regulation 270) for the same conditions of pressure and temperature.

Where frames, pads or branches are secured by rivets, the compensating area shall be calculated by the method given in Regulation 170.

Where frames, pads or branches are secured by welding, the compensating area shall be calculated by the method given in Regulation 279."

(*ii*) In clause (b) sub-clause (2) shall be substituted by the following, namely,—

"(2) Flat End Plates.—The maximum working pressure for welded in flat end plates as in figures Nos. 365/2, 365/3 and 365/4, shall be determined by the following formula:—

$$W.P. = \frac{fT^2}{Cd^2}$$

Where T = Minimum thickness of end plate.

d = Internal diameter of shell.

W.P. = Working Pressure.

C = 0·28

f = Maximum permissible working stress as in the table below :—

		Tensile Strength		Tensile Strength		Tensile Strength	
		38-44	24-28	41-47	26-30	44-50	28-32
Working metal temperature		Kg/cm²	lbs./sq. in.	Kg/cm²	lbs./sq. in.	Kg/cm.²	lbs/sq.in.
	C° F°						
upto	343 650	942	13,400	1019	14,500	1104	15,700
	371 700	928	13,200	1005	14,300	1069	15,200
	399 750	844	12,000	893	12,700	942	13,400
	427 800	738	10,500	766	10,900	794	11,300
	454 850	598	8,500	612	8,700	626	8,900
	482 900	443	6,300	443	6,300	443	6,300

The Intermediate values may be obtained by linear interpolation.

Where steels are intended for service at temperatures in excess of 371°C (700°F) this shall be so stated and silicon content shall not be less than 0·10 per cent or alternatively, the material shall pass the 'Proof test for creep quality of carbon steel plates of boiler plate quality' as in Appendix D.

Where flat and plates are bolted to flanges as in Figure 365/5 the dimensions of the flanges shall be as given in Appendix E. The thickness of the end plates shall be not less than that of the corresponding flanges.

Where the diameter of a hole in the flat end plate exceeds 2½T—70mm (2-3/4 inches) compensation shall be provided in accordance with Regulation 170 and 279.

(*iii*) In clause (*c*), the tables for the Minimum thickness of the flanges and adjoining the shell and the Minimum thickness of branches where external loads are not known shall respectively be substituted by the following tables :—

Thickness of shell plates		Minimum thickness of flange	
mm	in.	mm	in.
10 to 19	3/8 to 3/4	13	½
above 19 to 25	3/4 to 1	16	5/8
above 25 to 51	1 to 2	19	3/4
above 51	2	25	1

Nominal bore of branch	Thickness of cylindrical part of shell		Minimum body thickness
Upto and including 64 mm (2½ in.)	19mm(3/4 in.) and above	10 mm (3/8 in.)	for thinner shells not less than one half the thickness of the cylinderical part of the shell.
Over 64 mm(2½") upto and including 115mm (4½")	22mm(7/8") and above.	11mm (7/16 in.)	
Over 115 mm(4½") upto and including 203 mm (8")	25mm(1 in.) and above	13 mm (½in.)	
Over 203 mm (8") upto and including 254 mm(10 in.)	32 mm(1-1/4") and above	16mm (5/8 in.)	
Over 254 mm(10 in.)	32 mm (1-1/4") and above.		
	Subject to approval of the Chief Inspector of Boilers concerned.		

(199) For clause (*a*) of regulation 368, the following clause shall be substituted, namely :—

368. *Othr Fitting and Mountings.*—(*a*) Valve chests of bronze for stop valves upto 76mm (3 in.) diameter of bore may be attached directly to iron and steel pipes when pressures do not exceed 8·4 kg/cm² (120 lbs/sq. in.) gauge and temperature not exeeding 218°C (425°F). The attachment may be by direct screwing to the steam pipe or by means of flanges.

(200) in Regulation 370, for clause (*b*) and Table 5, the following clause and Table shall be substituted, namely :—

(*b*) The percentage allowance for expansion of piping at various temperatures shall be based on Table 5.

Table 5. Expansion allowance

Range of temperature		Expansion
Degrees Centigrade	Degrees Fahrenheit	Percent
16—121	60—250	0·130
16—149	60—300	0·166
16—177	60—350	0·203
16—204	60—400	0·241
16—232	60—450	0·279
16—260	60—500	0·319
16—288	60—550	0·359
16—316	60—600	0·401
16—343	60—650	0·443
16—371	60—700	0·486
16—399	60—750	0·530
16—427	60—800	0·574
16—454	60—850	0·620
16—482	60—900	0·666

(201) in Regulation 374, in clause (*b*), for the figures, abbreviations and words "100 lbs. per square inch", the figures, abbreviations and brackets "7 kg/cm² (100 lbs /sq. in.)" shall be substituted ;

(202) in Regulation 376,—

(*i*) in clause (*d*), for the figure and symbol " 2′′", the figures, abbreviations and brackets "51 mm (2 in.)" shall be substituted ;

(*ii*) in clause (*f*), for the figures and abbreviations "2,00,000 lbs.", the figures, abbreviations and brackets " 90718 kgs. (2,00,000 lbs.) " shall be substituted ;

(203) in clause (*a*) of Regulation 379, for the figures and words "50 pounds per square inch ", the figures, abbreviations, brackets and words "3·5 kgs./cm² (50 lbs. per square inch) shall be substituted ;

(204) in Regulation 382, for the words, figures, abbreviations and symbol "two and a half inches ", "one inch", "3/8′′", " three inches", " one quarter inch" and "1/64 inch", the figures, abbreviations, brackets and words " 64 mm (two and a half inches)", "25 mm (one inch) ", " 10 mm (3/8 inch) ", "76 mm (three inches)", "6 mm (one quarter inch) " and "0·4 mm (1/64 inch) " shall respectively be substituted ;

(205) in regulation 383,—

(*i*) in clause (*b*), for the portion beginning with " H.S. =:"and ending with "belt of shell in feet " the following portion shall be substituted, namely :—

" H. S.=2 L (3·14 d+D)

L is the length of the boiler between end plates,

d is the mean external diameter of the furnace and

D is the internal diameter of the largest belt of shell " ;

(*ii*) for clause (*g*), the following clause shall be substituted, namely :—

(*g*) *For Electrode Boilers.*—The heating surface shall be calculated as follows:—

$$\text{Heating surface} = \frac{E}{C}$$

where E= the equivalent evaporation at 100°C (212°F) under normal load which is $C_1 \times KW$

C=29·3 kg/cm² (6 lb/ft.²) Where C_1=1·59 kg (3·5 lbs.).

K. W., the Kilowatts absorbed at the stated voltage when the water in the boiler has a specific resistance of not less than 508 ohms per cm³ (200 ohms per inch cube) at 65·6 °C (150°F) and while the boiler is delivering its normal out-put of steam at its working pressure with the feed water temperature of 15·6° C (60°F).

(206) For regulation 384, the following regulation shall be substituted, namely :—

384. *Boiler ratings.*—The Boiler rating shall be the number of square metres multiplied by 10·764 and rounded off to the nearest whole figure (or the number of square feet to the nearest whole figure), in the heating surface of the boiler as determined under Regulation 383.

(207) for clause (*b*) of Regulation 391, the following clause shall be substituted, namely :—

(*b*) In making calculations for a wasted part of a boiler shell e.g., along the line of seating blocks of a Lancashire boiler, the Inspector shall use the following formula,—

$$\text{W.P.} = \frac{2t^1 \times S}{D \times F}$$

Where t^1=thickness of wasted plate, where thinnest.

S=minimum tensile strength of material of shell

D=internal diameter of shell

F=factor of Safety, which shall not be less than 4.

(208) in Regulation 392, in clause (*j*), for the figures and word " 7/8 inch", "7′′" and "1 inch ", the figures abbreviations, brackets and words " 22mm (7/8 in)" " 177 mm (7 inches" and " 25 mm (1 inch)" shall be substituted ;

(209) For regulation 395A the following regulation shall be substituted namely :—

"395A. *Inspection Fees.* The inspection fee for boilers constructed in India shall be calculated at three times the registration fee of a boiler inclusive of all charges to be levied for travelling expenses of the Inspecting Authority and his attending staff.

Fees for inspection of boiler scantlings and tubes during construction shall be charged as under :—

Boiler Scantlings	
Upto 1·85 sq. metres (20 sq. ft.) of outside surface	Nil.
Above 1·85 sq. metres (20 sq. ft.) and upto 4·64 sq. metres (50 sq. ft.) of outside surface.	One half of the registration fee of the boiler for which the part is intended,
Above 4·64 sq. metres (50 sq. ft.) of outside surface	An amount equal to the registration fee of the boiler for which the part is intended.

(210) for Regulation 397, for the figures, symbol and abbreviation "650°F," the figures, symbols, abbreviations and brackets " 343 °C (650°F) " shall be substituted ;

(211) in Regulation 408,

(*i*) for the figures and words " 1/8 inch " and "1 inch ", the figures, abbreviations and brackets " 3mm (1/8 in) " and "25 mm (1 in.)". shall respectively be substituted ;

(*ii*) the words " in inches " in the two places where they occur shall be omitted ;

(*iii*) for the portion beginning with "W.P.= ....." and ending with "K=factor (see Equation above), the following portion shall be substituted, namely :

$$WP = \frac{(t-C_1)CS}{70DK} \quad \ldots\ldots\ldots \text{Eqn. (97)}$$

Where t =Thickness of plate,

W.P. =working pressure,

D =outside diamter of the flange.

K =a factor dependent upon the ratio h where h is the external height, generally obtained from the curve shown in figure 22 or by Equation 75. In no case shall K be taken as less than :—

$$1{\cdot}15\ \frac{R}{D} \text{ or } 0{\cdot}12\ \frac{D}{R}$$

S =Minimum ultimate tensile stress of plate,

C =Constant as follows :—

a Where the end plate is in one peace,

c =35

b =where the end plate is not in one piece,

C =32, where Class I requirements are compliled with.

C =27, where Class II requirements are complied with.

C_1 =0·16 cm (0·06 in.)

(*iv*) for the figure and abbreviation "2 in.", the figures, abbreviations and brackets " 51 mm (2 in.)" shall be substituted ;

(*v*) for the portion beginning with "Where the diameter of such opening....." and ending with" K=factor (see equation above)", the following portion shall be substituted, naemly :

Where the diameter of such opening is not greater than 64 mm (2½ in.) and the value of the ligament $\frac{P-D}{P}$ is not less than $\frac{1}{K}$ compensation is not required.

Where d is greater than 4 mm(2½in.) or p-d/P is less than 1/K full compensation shall be provided.

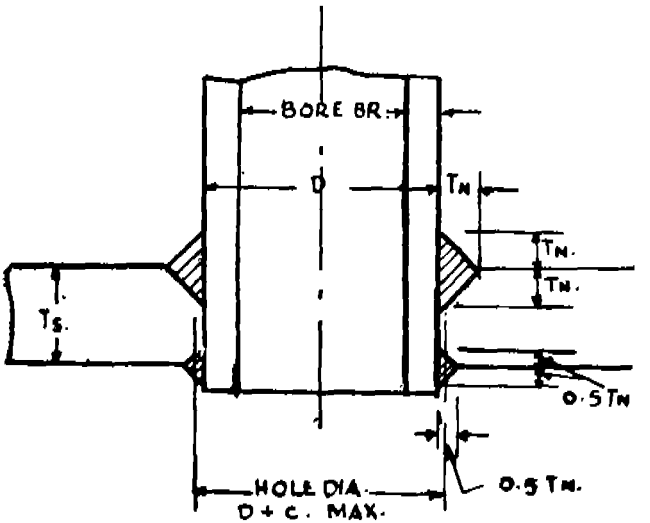
Where P =pitch of openings,
D =diameter of openings,
K =factor (see Equation above).

(212) in Regulation 409,—

(*i*) for the figures, abbreviations and words " 250 lbs./sq. in.", "3/4 inch", "one quarter inch", "5 inches" wherever they occur, the figures, abbreviations, brackets and words "175 kg/cm² (250 lbs. sq. in.) ", "19 mm (3/4 in.) "6 mm (one quarter inch) " and "127 mm (5 inches)", shall respectively be substituted ;

(*ii*) the words "in inches " wherever they occur shall be omitted ;

(*iii*) for the Figures 41-A, 41-B, 42-A, 42-B, 42-C, and 43, the following Figures shall respectively be substituted, namely :—



WHERE C = 3 MM. (1/8 IN.)

FIG. 41 A

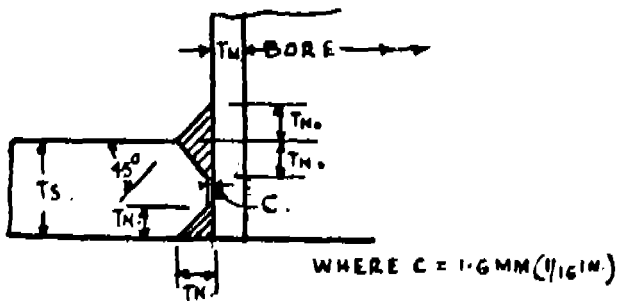
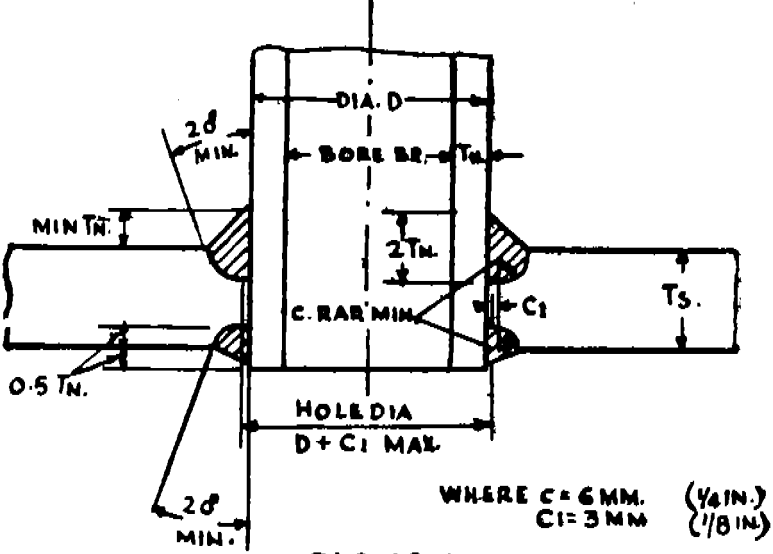


FIG. 41 B.

MINIMUM WELD ATTACHMENT FOR STANDPIPES 127 MM (5IN.) BORE AND UNDER, WITH PLATE THICKNESS TS EQUAL TO (1·5TN.) OR GREATER.

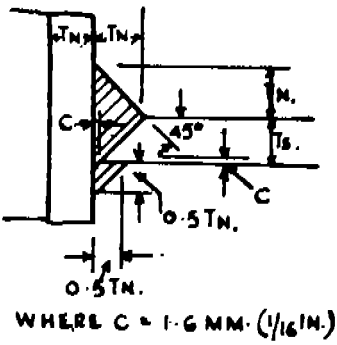
FIGS. 41A AND 41-B MINIMUM WELD ATTACHMENT FOR STANDPIPES UPTO AND INCLUDING 127 MM (5IN.) BORE NOT REQUIRING COMPESATING PLATES.

NOTE:- THE TYPES "A" AND "B" ARE PERMITTED ONLY WHERE THE ELECTRODES AND TECHNIQUE TO BE USED HAVE BEEN SHOWN BY SEPERATELY PREPARED TEST SPECIMENS TO GIVE FULL PENETRATION, WITH SOUND WELD METAL AT THE ROOT OF THE GROOVES.



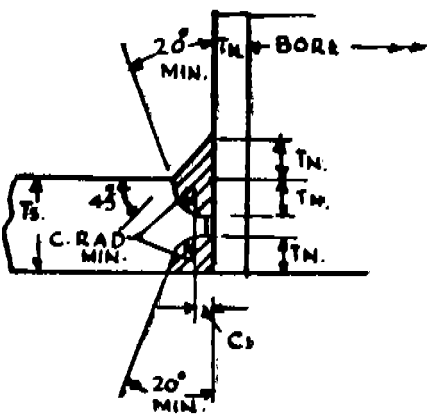
WHERE C = 6 MM. (¼ IN.)
C1 = 3 MM (⅛ IN.)

FIG. 42.A.



WHERE C = 1.6 MM. (1/16 IN.)

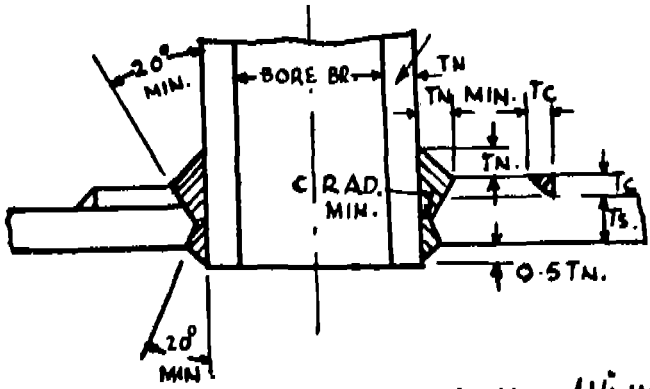
FIG. 42.C.
MIN. WELD DIMENSIONS WHERE PLATE THICKNESS Ts IS LESS THAN 1.5 Tn.



WHERE C = 6 MM. (¼ IN.)
C1 = 3 MM. (⅛ IN.)

FIG. 42 B.

FIGS. 42-A, 42-B AND 42-C MINIMUM WELD ATTACHMENTS FOR STANDPIPES OVER 127 MM. (5 IN.) BORE. NOT REQUIRING COMPESATING PLATESS.



WHERE C = 6MM. (1/4 IN.)

MINIMUM WELD ATTACHMENT FOR STAND PIPES OVER 127 MM OR (5IN.) REQUIRING COMPENSATING PLATES

FIG. 43.

FORMS OF WELDED JOINTS FOR FLAT END PLATES FOR CLASS II BOILERS NOT EXCEEDING 508 MM. (20IN.) DIAMETER.

(*iv*) for the portion beginning with " The thickness of the stand pipe ', ending with " stand pipe in inches, the following portion shall be substituted namely :—

The thickness of the stand shall not be less than 6mm (1/4 in) or that given by the following formulae, whichever is the greater.

a. For working pressure upto and including 17·5 kg/cm² (250lbs./sq. in)—t=D+C

b. For working pressure above 17·5 kg/cm² (250 lbs./sq. in)—t=D+C_1

Wheare t=thickness of stand pipe,

D =Outside diameter of the stand pipe.

C =3 mm (1/8 in.)

C_1 =4/8 mm (3/16 in.)

(213) in Regulation 412,—

(*i*) for the portion beginning with "W.P $= \frac{2S(T-2)^2}{D^2}$, ..' and ending with "3/8 inch, the following portion shall be substituted, namely :

$$W.P. = \frac{CS(t-C_1)^2}{D^2} \qquad \text{Eqn. (98)}$$

Where t- thickness of plate

W.P. =Working pressure.

D =Diamter of the pitch circle of the bolts or rivets when the plate is attached to an outside flange ort he internal diamter of the shell when the plate is attached to an inide flange

S =Minimum tensile stress of the plate.

C =0·915

C' =0·16 cm (0·06 in.)

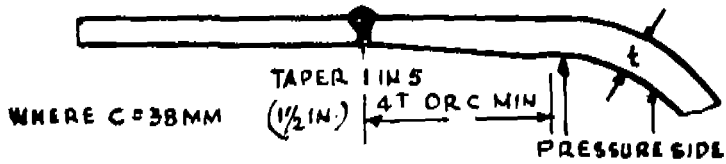
In no case shall the thickness of an unstayed flat-end plate be less than 10mm (3/8in.)

(*ii*) for the figures and word "2½ inches " in the two places where they occur, the figures, abbreviations, brackets and word "64mm (2½in ceas)"hall be substituted ;

(*iii*) the words " in nches " shall be omitted ;

(214) in Regulation 413, for the figures and word "3/16 inch", the figures, abbreviations and brackets ,' 8 mm (5/16 in.)" shall be substituted ;

FORMS OF WELDED JOINTS FOR CIRCUMFERENTIAL SEAMS. ACCEPTABLE FOR ALL CLASSES OF BOILERS



ACCEPTABLE FOR CLASS II BOILERS

FIG. 44.

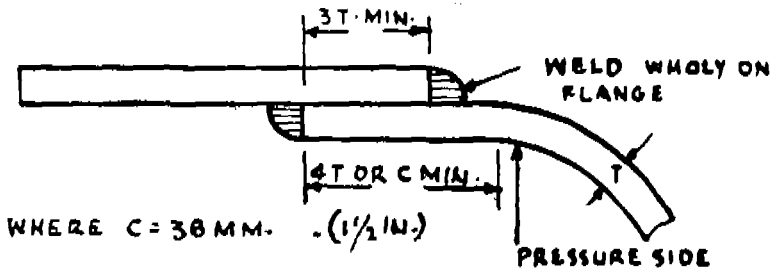
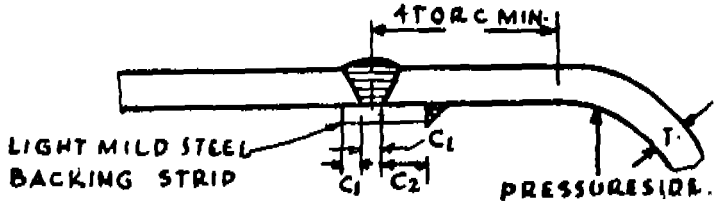


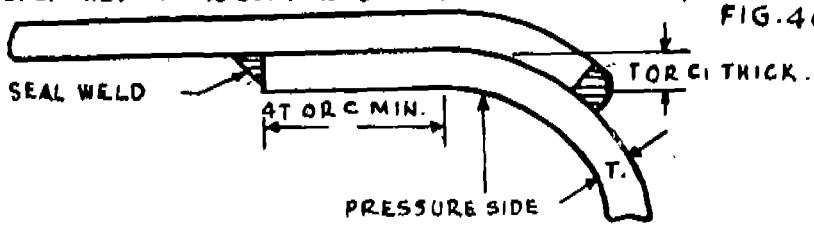
FIG. 45.



WHERE C = 38 MM (1½ IN.)
C1 = 5 MM (3/16 IN)
C2 = 10 MM (⅜ IN.)

FOR PLATES OVER 19 MM (¾ IN.) THICK, WIDTH OF GAP BETWEEN THE EDGES OF THE PLATES TO BE AGREED UPON BY INSPECTING AUTHORITY & MANUFACTURER

FIG. 46.



WHERE C = 38 MM. OR (1½ IN.)
C1 = 13 MM OR (½ IN.)

FIG. 47.

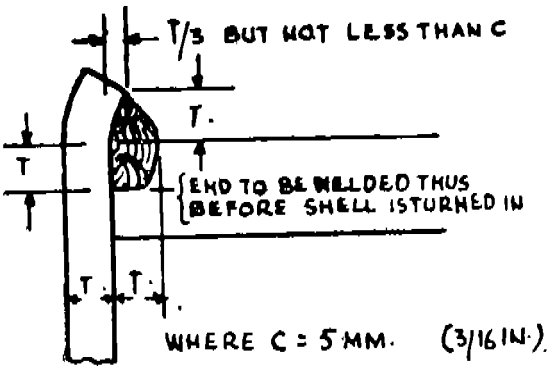


FIG. 48.

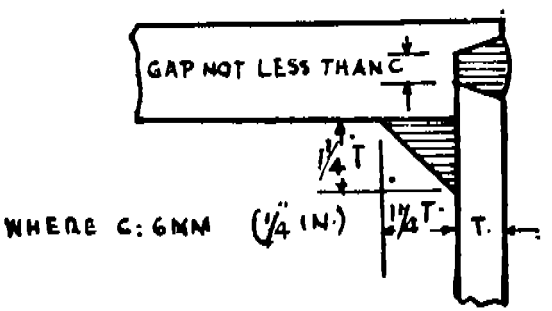


FIG. 49.

(215) In Regulation 416,—

(*i*) for the Figures 44—49, the following Figures shall respectively be substituted, namely

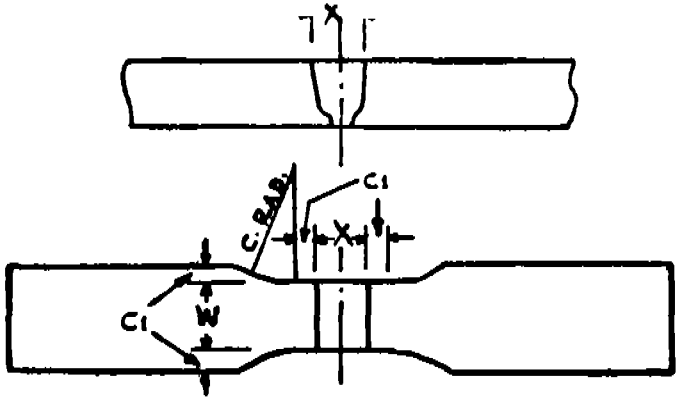
(*ii*) for the portion beginning with " Class I boilers" and ending with "requirements" the following portion shall be substituted, namely :—

Class I Boilers. The working pressure of which exceeds 11·6 kg/cm². (165 lbs/sq. in.) or the product of the working pressure in kg/cm² and the internal diameter in centimeter exceeds 1473 (or the product of the working pressure in pounds/sq. in. and in the internal diameter in inches exceeds 8250).

Class II Boilers. The working pressure of which is 11·6 kg/cm². (165 lbs/sq.in) and below or the product of the working pressure in kg/cm² and the internal diameter in centimeter is below 1473 (or the product of the working pressure in pounds/sq. in. and the internal diameter in inches is below 8250).

(216) In Regulation 417, for the figures and abbreviation " 1/32 in.", the figures, abbreviations and brackets " 0·8 mm (1/32 in.)" shall be substituted;

(217) In Regulation 418, for the figures and abbreviations " 1½ sq. in.", the figures, abbreviations and brackets " 968 mm². (1½ sq. in.)" and for figure 51, the following Figures shall be substituted, namely:—



WHERE C = 64 MM (2½ IN.)
C1 = 6 MM (¼ IN.)

W = NOT LESS THAN FULL PLATE THICKNESS WITH A MINIMUM WIDTH OF 38 MM (1½ IN).

SPECIMEN (1) TENSILE TEST FOR JOINT

TENSILE TEST FOR JOINT
FIG. 51.

(218) in Regulation 419, for the figures, words "1 1/4 inches", "1/16 inches", 1/8 inch", the figures, abbreviations and brackets " 32 mm (1 1/4 in.)", "1·6 mm (1/16 in.)" and "3 mm (1/8 in.)' shall respectively be substituted;

(219) in Regulation 425 :—

(*i*) for Equation (99) and entries below it, the following Equation and entries shall be substituted, namely:—

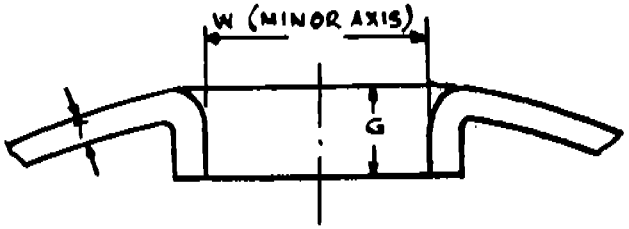
$$W.P. = \frac{(t - C_1)\,SC}{70D} \qquad \text{.....Eqn. (99)}$$

t =thickness of shell,
D =internal diameter of shell,
S =ultimate tensile stress,
C =32 for Class I boilers,
C =27 for Class II boilers,
C_1 =0·16 cm (0·06 in.)

(*ii*) for the table, the following table shall be substituted, namely —

Minimum thickness for fusion welded shells

Class	Internal diameter	Minimum thickness
I	..	6 mm (1/4 in.)
	Upto and including 610 mm (24 inches) .	6 mm (1/4 in.)
	Over 610 mm (24 in.) upto and including 914 mm (36 inches)	8 mm (5/16 in.)
	Over 914 mm (36 inches) . . .	10 mm (3/8 in.)



NOTE:— T = CALCULATED PLATE THICKNESS + C
WHERE C = 3 MM. (1/8 IN.).
G = $\sqrt{Tw}$.

ELLIPTICAL PRESSED MANHOLES IN DISHED END PLATE

FIG. 55.

(221) in Regulation 429, for the figures and words " 2½ inches or the pitch in inches" the figures, abbreviations, brackets and word " 64 mm (2½ inches) or the pitch" shall be substituted ;

(222) for the table in Regulation 434, the following table shall be substituted, namely:—

Internal diameter	Minimum thickness
Upto and including 610 mm (24 in.)	. 6 mm (1/4 in.)
Over 610 mm upto and including 914 mm (36 inches) .	. 8 mm (5/16 in.)
Over 914 mm (36 in.)	. 10 mm (3/8 in.)

(223) for regulation 504, the following regulation shall be substituted, namely:—

504. *Hydraulic test for new economisers.*—For all new economisers the hydraulic test must be applied as shown below:—

On components before assembly	Design pressure	Hydraulic test pressure
Cast iron tubes, headers and bends.	..	Twice working pressure. Minimum pressure 49 kg/cm². (700 lbs/sq. in.)
Steel tubes and bends .	35 kg/cm² (500 lbs/sq. in.) or less.	70 kg/cm². (1000 lbs/sq. in.)
Ditto . . .	Above 35 kg/cm². but not exceeding 70 kg/cm². (1000 lbs/sq. in.)	Twice the working pressure.
Ditto	Above 70 kg/cm² (1000 lbs/sq. in.)	70 kg/cm². (1000 lbs/sq. inch) above the working pressure.
Headers	Below 70 kg/cm². (1000 lbs/sq. in.)	Twice the working pressure.
Ditto	Above 70 kg/cm². (1000 lbs/sq. in.)	Working pressure *plus* 70 kg/cm². (1000 lbs/sq. in.)

NOTE :—"Working pressure" shall be the highest pressure at which the economiser relief Valve are to be set.

The above test pressure shall be held for a minimum period of ten minutes.

(2 25) in Regulation 506, in clause (a), for the figures and abbreviations 1·2 in. the following figures, abbreviations and brackets shall be substituted, namely:—

30·48 mm.(1·2 in.)

(226) in the tables below clause (a) of Regulation 508, the following tables shall be substituted namely :—

Group	Weight of castings	Test requirements
1	Upto 12·7 kgs (28 lbs)	One test for each 1524 kgs (30 cwts) of castings or part thereof.
2	Over 12·7 kgs (28 lbs) and upto 50·8 kgs (1 cwt).	One test for each 2032 kgs (2 tons) of castings or part thereof.
3	Over 50·8 (1 cwt) and up to 1016 kgs (1 ton)	One test for each 3048 (3 tons) of castings or part thereof.

In the above groups 1, 2 and 3, all castings represented by one test must be poured from the same eadle of same heat as the bar or/bars provided for the test.

4	Over 1016 kgs (1 ton) and important castings.	One test for each 4064 kgs (4 tons) of castings or part thereof or for each casting weighing 4064 kgs (4 tons) or more.

(227) for the table in regulation 509, the following table shall be substituted, namely :—

B	D	A	P	R	C	E	F	L	L1
30·48mm (1·20 in.)	20·27mm (0·798 in.)	322·6mm² (0·50 sq. in.)	51mm (2 in.)	89mm (3½ in.)	51mm (2 in.)	29mm dia 3mm pitch (11/8 in. dia. 0·111 in. pitch or 0·143 in. pitch)	29mm (11/8 in.)	210mm (8¼ in.)	149mm (57/8 in.)

(228) For regulation 510, the following regulation shall be substituted, namely:—

510. The manufacturer shall, on the basis of design details, satisfy the Inspecting Authority regarding the design and strength of all parts of cast iron economisers subject to the following maximum working pressures:—

	Max. W.P.
(1) Ordinary Vertical Tube	23 kg/cm². (325 lbs/sq. in.)
(2) Ordinary Vertical Tube with strengthened tubes	26 kg/cm². (375 sq. in.)
(3) Ring Stay Vertical Tube	33 kg/cm². (475 lbs/sq. in.)
(4) Gilled Tube Type of approved design . .	45·5kg/cm². (650 lbs/sq. in.)

(229) In Regulation 512, for the figures, symbol and abbreviations " 40°F" and " 120ft." the figures, symbol, abbreviations, brackets and word " 22°C (40°F)" and " 36·6 meters (120 ft.)" shall respectively be substituted;

(230) In Regulation 515, in sub-clause (iv) of clause (b), for the figure and word " 2 inches" the figures, abbreviations, brackets and word " 51 mm (2 inches)" shall be substituted;

(231) In Regulation 517,—

(*i*) for clause (b), the following clause shall be substituted, namely:—

(*b*) Roller expanded tubes shall project through the neck or bearing part in the holes by at least 6 mm (1/4in.) and shall be secured from drawing out by being bell-mouthed to the extent of 0·8 mm (1/32 in.) for each 25 mm (1 in.) in diameter plus 1·6mm (2/32 in.).

(*ii*) In clause (d) for the figures and word " 1/2 inch" the figures, abbreviation, brackets and word " 13 mm (1/2 inch)" shall be substituted ;

(232) For Regulation 518, the following Regulation shall be substituted, namely:—

518. Joints, Bolts, Studs and Flanges.—

(*a*) The maximum working pressure for the bolts shall be determined by the following Formula:—

$$W.P. = \frac{N \times C}{A}(D - C_1)^2 \quad \ldots\ldots\ldots \text{Eqn. (121)}$$

Where N =No. of bolts securing the parts.

D =Bolt diameter measured over the threads.

A =The area exposed to pressure which is assumed to be bounded by a line midway between the pitch line of the bolts and the inner edge of the flange where flat joints are used with joint rings. Where conical joint faces are used with joint rings, of curvilinear cross section, the area exposed to pressure shall be assumed to extend to the rest of the thread where the tube ends are screwed, or to a corresponding boundary line if the flanges are attached by other means.

C =330 kg/cm² (4,700 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² (28 tons sq. in.) minimum ultimate tensile stress where the diameter over thread is less than 19mm (3/4 in.)

=359 kg/cm² (5,100 lbs/sq. in.) for steel bolts or studs of 47 kg/mm² (30 tons/sq. in.) minimum ultimate tensile stress where the diameter over thread is less than 19mm (3/4 in.)

C =394 kg/cm² (5,600 lbs/sq. in.) for steel bolts or studs of 55kg/mm² (35 tons/sq. in.) minimum ultimate tensile stress where the diameter over thread is less than 19mm (3/4 in.)

C =394 kg/cm² (5,600 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² (28 tons/sq. in.) minimum tensile stress where the diameter over threads is not less than 19mm (3/4 in.) and not greater than 22mm (7/8 in.)

C =492 kg/cm² (7,000 lbs/sq. in.) for steel bolts or studs of 44 kg/mm² minimum ultimate tensile stress where the diameter over thread is greater than 22mm (7/8 in.)

C_1 =1·299 cm, P being the pitch of thread in cm.
(1·28 inches, n being the number of threads per inch).

$\frac{\quad}{n}$

Where the bolts or studs used, have a tensile strength exceeding 50 kg/mm² (32 tons/sq in) a plate shall be permanently fixed to the economiser structure in a prominent position drawing attention to this fact in case replacements of bolts or studs are necessary. In no case shall the nuts be exposed to the action of the flue gases

(b) The thickness of each flange shall be not less than that given by the following equation.

$$t = \frac{\sqrt{PD(D - D)}}{C}$$

Where t = Thickness of flange,
P = Working pressure (gauge),
D = Outside diameter of tube,
D_1 = Pitch circle diameter of bolts or studs. Provided that such flange is cast integral with the body and with appropriate internal corner radius,
C = 288 kg/cm² (4096 lbs /sq. in.)

In no case however the thickness of a flange be less than 19mm (3/4 in)

(233) In Regulation 519,—

(i) in clause (b), for the figures and symbol "2", the figures, abbreviations and bracket "5, mm (2 in)" shall be substituted;

(ii) in clause (i), for the figures, abbreviations "1000 lbs /sq. in", the figures, abbreviations and brackets "70 kg /cm² (1000 lb /sq. in)." shall be substituted;

(234) In regulation 520, for the first para, the following paragraph shall be substituted, namely:—

520. *General* — Feed pipes may be made of steel, cast iron or copper but cast iron pipes will not be accepted for a working pressure over 14 kg/cm² (200 lbs/sq. in) or 218°C (425°F) Copper feed pipes shall be solid drawn and not exceed 203mm (8 in) external diameter and may be used for a working pressure not exceeding 24 5 kg/cm² (350 lbs/sq in) or 149°C (300°F)

(235) In Regulation 522, for Equation (122) and the entries below it, the following Equation and entries shall be substituted, namely:—

$$W.P. = \frac{C(t - C_1)}{d} \quad \text{Eqn (122)}$$

Where t = thickness,
d = the external diameter of the pipe,
C = 292 kg/cm² (4160 lbs /sq in)
C_1 = 0 48 cm (3/16 in)

(236) In Regulation 523, in clause (b), for Equation (123), and the entries below it, the following Equation and entries shall be substituted, namely —

$$W P. = \frac{C(t - C_1)}{d} \quad \text{Eqn (123)}$$

Where t = thickness,
d = external diameter of the pipe,
C = 422 kg/cm² (6,000 lbs/sq. in.
C_1 = 0 08 cm (0 03 in)

(237) In Regulation 525, for clause (b), the following clause shall be substituted, namely:—

(b) The fitness of the economiser parts shall be determined as per the following formulae:—

(1) *Cast iron smooth tube economisers with pressed socket joints*

$$W P. = \frac{AZ}{Ca} + \frac{C_1 N}{n} \quad \text{Eqn (124)}$$

Where W P. = Design pressure,
A = Area of contact surface of a single socket,
a = Cross sectional area measured on the mean diameter of a socket hole,
Z = Breakdown load of an unreinforced socket joint,
N = Number of stays per header,

n =Number of sockets per header,

C =551.6 cm^2 (70 sq. in.)

C_1 =15·8 kg/cm^2 (225 lbs./sq. in.)

For existing standard designs the breakdown load of an unreinforced socket joint, shall be taken as not greater than 6113.5 kgs or (13,500 lbs.). For designs not already, in use before the date of this standard, the corresponding figure shall be taken as not greater than 75 percent of the load as determined by experiment.

(ii) *Headers of approximately rectangular cross section.*

$$W.P. = \frac{C(t-C_1)^2}{b^2} \quad \text{Eqn. (125)}$$

Where t =thickness,

b =Distance between the sides of header supporting the surface,

W.P. =Design pressure (gauge),

C =792 kg/cm^2 (11,264 lbs/sq. in.) where the water side surface is flat,

=1,584 kg/cm^2 (22,528 lbs/sq. in.) where the water side surface is curved,

provided that the curvature is continued without interruption and the thickness at each end of the side is not less than that determined with

C =792 kg/cm^2 (11,264 lbs./sq. in.)

C_1 =0·16 cm (0·06 in.)

In no case, however, shall the thickness of the side of the header be less than 13mm (1/2 in.) at any part.

(iii) *Headers of approximately circular cross section.*

$$W.P. = \frac{0{\cdot}6K\,(t-C)}{D} \quad \text{Eqn. (126)}$$

Where t =thickness,

W.P. =Design pressure,

D =Outside diameter of header,

K =596 kg/cm^2 (8,480 lbs/sq. in.) for grade 16.5 iron.

=540 kg/cm^2 (7,680 lbs/sq. in.) for grade 14 iron,

=495 kg/cm^2 (7,040 lbs./sq. in.) for Grade 12 iron,

C =0·40 cm (5/32 in.)

The minimum thickness of plain cylindrical portion of a header in that part of the length which does not contain tube holes shall comply with the requirements of sub-clause (v).

In no case, however, shall the thickness at any point be less than 13mm or 1/2 in.

(iv) *Tubes.*

$$W.P. = \frac{K(t-C)}{D} \quad \text{Eqn. (127)}$$

Where t =thickness,

W.P. =Design pressure (gauge),

D =Outside diameter of tube,

K = 596 kg/cm^2 (8,580 lbs/sq. in.) for grade 16·5 iron.

=540 kg/cm^2 (7,680 lbs. sq. in.) for grade 14 iron,

=495 kg/cm^2 (7,040 lbs/sq. in.) for grade 12 iron,

C =0·32 cm (1/8 in.) for portion where gills act as reinforcement,

=0·40 cm or 5/32 in. for portion not reinforced.

In no case, however, shall be the thickness at any point be less than 7mm (11/32 in)

(v) *Manifold pipes*

$$W.P. = \frac{0{\cdot}8K\,(t-c)}{D} \quad \text{Eqn. (128)}$$

Where t = thickness,
W.P. = Design pressure (gauge),
D = Outside diameter of pipes,
K = 596 kg/cm² (8,480 lbs/sq. in.) for grade 16·5 iron
= 540 kg/cm² (7,680 lbs/sq. in.)
= 495 kg/cm² (7,040 lbs./sq. in.)
C = 0·40 cm (5/32 in.)

In no case, however, shall the thickness of a manifold pipe or branch be less than 11mm (7/16 in.)

(vi) *Cast iron economisers with extended surface horizontal tubes. Connector Bends*

$$W.P. = \frac{K(t-C)}{D} \quad \text{Eqn. (129)}$$

Where t_1 = thickness of bends,
W.P. = Design pressure (gauge),
D = Outside diameter of bend,
K = 596 kg/cm² (8,480 lbs/sq. in) for grade 16·5 iron,
= 540 kg/cm² (7,680 lbs/sq. in.)
= 495 kg/cm² (7,040 lbs/sq. in.)
C_1 = 0·4 cm (5/32 in.)

In no case, however, shall the thickness of a connector bend be less than 10·3mm (13/32 in.)

Tubes.—To comply with equation (127)

Manifold pipes.—To comply with equation (128)

(238) in Regulation 531, in the note below clause (b), for the figures, symbol and abbreviation "100°F", the figures, symbol, abbreviations and brackets "38°C (100°F)" shall be substituted

9) For regulation 532, the following regulation shall be substituted, namely:—

(240.) *Economiser rating*:—The rating shall be equivalent to the area of the heating surface in square meter multiplied by 10·764 (or the heating surface in square feet) which shall be computed from the tubes and headers.

(241) In Form I referred to in Regulation 386 and 387, for the entries in column 1 or the Table, the entries in column 2 shall be substituted ; and the word "tons" in the first line under Gusset Stay Particulars shall be omitted ;

Miles	Kilometres / miles	
lbs.	kg/cm² / lbs/sq. in.	
T to tons	kg/mm² / tons/in.² to	kg/mm² / tons/in.²
in	mm / in.	
sq. in.	cm² / sq. in.	
. ft.	m² / sq. ft.	

$W.P. = \frac{(t-2) \times S \times J = \text{lbs.}}{C \times D} = \text{lbs.}$	$W.P. = \frac{(t-C_1)\ S \times J}{70 \times C \times D} = \frac{kg/cm^2}{\text{lbs./sq. in.}}$
$W.P. = \frac{(t_1-1)^2}{D^2} = \text{lbs}$	$W.P. = \frac{C\ (t-C_1)^2}{D^2} = \frac{kg/m^2}{\text{lbs/sq. in.}}$
$U.P. = \frac{[(t_1-1)^2 + (t-1)^2}{D_2} = \text{lbs.}$	$W.P. = \frac{C \cdot [t^1 - c^1[(t-c_1)^2 \quad (r_1-c_1)^2]}{D2}$ $= \frac{kg/cm^2}{\text{lbs/sq. in.}}$
$\frac{3 \cdot 47\ (t-1)}{\sqrt{W.P.}} = \text{ins.}$	$W = \frac{C\ (t-c_1)^2}{W.P.} = \frac{cm}{ins.}$
$\frac{3 \cdot 7\ (t-1)}{\sqrt{W.P.}} = \text{ins.}$	$W = \frac{\sqrt{C(t-c_1)^2}}{W.P.} = \frac{cm}{ins.}$
$(G-N_2D_2)\ (t-2) \cdot 037 \ldots\ldots\ldots$	$(G-N^2D^2)\ (t-C_1) \times 1 \cdot 184$
$(G_1-D_2)\ (t-2) \cdot 037 \ldots\ldots\ldots$	$(G_1-D_2)\ (t-C_1) \times 1 \cdot 184$
$\frac{8500 \times C}{A} \ldots\ldots\ldots$	$\frac{C_2 \times C}{A} \times 1 \cdot 184$
$W.P. = \frac{10000\ \pi d^2}{DACK}$	$W.P. = \frac{C_1\ \pi d^2}{DACK}$
$W.P. = \frac{33333 d^2}{DACK} \ldots\ldots\ldots\ldots$	$W.P. = \frac{C_2 d^2}{DACK}$
$W.P. = \frac{160000\ B^2H^2}{DACK\ (3B+1 \cdot 8H)} \ldots\ldots\ldots$	$W.P. = \frac{C_2 B^2 H^2}{DACK\ (3B^2+1 \cdot 8H)}$
$As = A \sqrt{(1 + \frac{1 \cdot 5T}{1000})} \ldots\ldots\ldots\ldots$	$As = A \sqrt{K_1}$

(242) In Form II, referred to in Regulation 4(c) (i), for the entries in column 1 the entries in column 2 shall be substituted ;

Feet	$\frac{cm}{ft.}$
inches	$\frac{cm}{inches.}$
lbs.	$\frac{kg/cm^2}{\text{lbs./sq. in.}}$

(243) in Form III, referred to Regulation 4(c) (ii), for the entries in column 1 of the Table, the entries in column 2 shall be substituted ;

lbs.	$\frac{kg/cm^2}{\text{lbs/sq. in.}}$
Sq. feet.....	$\frac{m^2}{\text{sq. ft.}}$
Total evaporation P.H.	Total evaporation $\frac{\text{kgs}}{\text{lbs.}}$ P.H.
inches.....	$\frac{mm}{\text{inches}}$

Thickness or plates in 32nd or diameter ..... Thickness of plates in mm or $\frac{\text{mm}}{\text{inch}}$

in inches..... $\frac{\text{mm}}{\text{inches.}}$

tons..... $\frac{\text{kg/mm}^2}{\text{tons/sq. in.}}$

lbs/sq. in ..... $\frac{\text{kg/cm}^2}{\text{lbs/sq. in.}}$

(244) in Form III-A referred to in Regulation 4(e), for the words "lbs' per sq. in." and "F°" wherever they occur, the following shall be substituted, namely :—

$\frac{\text{"kg/cm}^2\text{"}}{\text{lbs/sq. in.}}$ and $\frac{\text{"C°"}}{\text{F°}}$

(245) in Form IV, referred to in Regulation 4(c) (iv), for the entries in column 1 of the Table, the entries in column shall be substituted ;

Ft. in. ..... $\frac{\text{cm}}{\text{ft. in.}}$

32 nds inch ..... $\frac{\text{mm}}{\text{inch.}}$

tons per sq. inch .... $\frac{\text{kg/mm}^2}{\text{tons/sq. inch.}}$

inches..... $\frac{\text{mm}}{\text{inches.}}$

(246) in Form V referred to in clause (c) of Regulation 381 and in Form VI referred to in Regulation 389, for the words "lbs./sq. in.", the following shall be substituted, namely :—

$\frac{\text{"kg/cm}^2\text{"}}{\text{lbs. /sq. in.}}$

(247) in Form VI referred to in Regulation 389, for the figures and abbreviations "200 sq. ft." the figures, abbreviations and brackets "18·58m² (200 sq. ft.)" shall be substituted ;

(241) in Form VIII referred to in Regulation 501(d), for the abbreviations "lbs." and "lbs. per sq. in", the following shall be substituted, namely :—

"kg/cm²" and $\frac{\text{kg/c m}^2\text{"}}{\text{lbs./sq. ir.}}$

(248) in Form VIII referred to in Regulation 501 (d),—

(i) for the abbreviations "lbs" and "lbs. per sq. in." the following shall be substituted, namely :—

"kg/cm²" and $\frac{\text{"kg/cm}^2\text{"}}{\text{lbs./sq. in.}}$

(ii) in column 2, the word, figures and letters "in 32nds" and in column 3, the words "to tons" shall be omitted,

(249) in Form IX referred to in Regulation 528, for the word 'lbs.", the following shall be substituted, namely :—

$\frac{\text{"kg/cm}^2\text{"}}{\text{lbs./sq. in.}}$

(250) in Form X referred to in Regulation 525 (e), for the abbreviations and letters "lbs. per sq. in." and "F°", the following shall be substituted, namely :—

$\frac{\text{"kg/cm}^2\text{"}}{\text{lbs./sq. in.}}$ and $\frac{\text{"C°"}}{\text{F°}}$

(251) in Form XI referred to in Regulation 530, for the abbreviations "lbs./per sq. in" and "F°", the abbreviations and brackets "kg/cm² (lbs./per sq. in.)" and "C°(F°)" shall be substituted ;

(252) for the figures "1·625" wherever they occur in Appendix A, the following shall be substituted, namely :—

"C1=41mm (1·625 in.)" ;

(253) in Appendix B,—

(i) for the table below Fig. 1, the following Table shall be substituted, namely:—

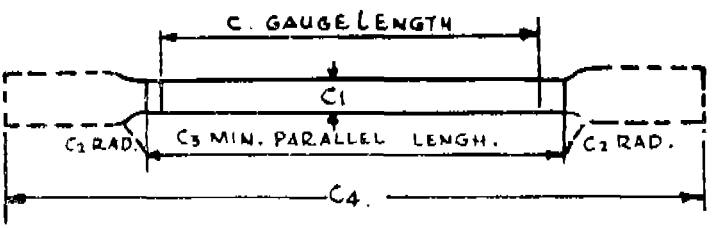
Nominal thickness of test test piece.		(i) Upto but not	(ii) including	(ii) (See note 3) 10mm (3/8 in.)	(iv) 10mm(3/8in) and thicker.
Width	W	13mm (½ In.)	25mm (1 in.)	38mm (1½in.) max.	38mm (1½ In.) max.
Gauge length	G	51mm (2 in.)	102mm (4 In.)	203mm (8 in.)	203mm (8 in.)
Parallel length (minimum)	P	64mm (2½ in.)	114mm (4½in.)	229mm (9 in.)	229mm (9 in.)
Radius at shoulder (minimum)	R	25mm (1 in.)	25mm (1 In.)	25mm (1 in.)	25mm (1 in.)
Approximate total length		203mm (8 in.)	305mm (12 In.)	457mm(12 in.)	457mm (12in.)

(ii) for Notes 2 and 3 below the Table so substituted, the following Notes shall be substituted, namely :—

2. For certain non-ferrous metals it is sometimes convenient to use the standard test piece that has a width 13mm (½ In.) and a guage length of 51mm (2 in.) for thickness exceeding 6mm (¼ in.)

3. At test piece of the dimensions given in Col. (iii) for material under 10mm (⅜ in.) nominal thickness is intended for ferrous metals only.

(iii) for Fig. 2, the following Figure shall be substituted, namely:—



WHERE C = 203 MM. (8 IN.)
C1 = 19 MM. (3/4 IN.).
C2 = 25 MM. (1 IN.).
C3 = 229 MM. (9 IN.).
C4 = 381 MM. (15 IN.).

IN TENSTILE TESTS ON SPECIAL SHEET & STRIP MATERIALS.
(E.G., STEEL USED FOR DEEP PRESSING OPERATIONS.)
THE ABOVE ALTERNATIVE TEST PIECE MAY BE USED.

TEST PIECE A1

FIG. 2

In

B", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted;

(*v*) for the figures and abbreviation "8 in.", "1¼ in." and "½ in.", occurring in paragraph headed "Length between abbreviation P to be not less than 9-D", the figures, abbreviations and brackets "203 mm (8 in.)", "38 mm (1½ in.)" and "13 mm (½ in.)" shall respectively be substituted;

(*vi*) for the figure and abbreviation "1 in." occurring in the sentence below "Test Piece B-1", the figures, abbreviations and brackets "25 mm (1 in.)" shall be substituted :

(*vii*) for the entries below Fig. 5, the following entries shall be substituted, namely :—

Gauge length G=51mm (2 in.)

Parallel length P to be not less than 57 mm (2-1/4 in.)

Diameter D=14·32mm (0·564 in.)

Cross-Sectional area A=161·3 mm² (1/4 sq. in.)

Radius at shoulder 13mm (1/2 in.) minimum for wrought metals and 64mm ⅝(2½ in.) minimum for cast metals.

0·125 in.=3·18mm (0·125 in.)

(*viii*) for the Table below Fig. 6, the following Table shall be substituted, namely :—

Diameter D	Cross-Sectional area A	Gauge length G	Parallel length P (Minimum)	Radius at shoulder R (Minimum)	
				Wrought metal	Cast metal
28·65mm (1·128 in.)	645·2mm² (1·0000 sq. in.)	100mm (4·00 in.)	114 mm (4·5 in.)	25·0 mm (1·00 in.)	127 mm (5·00 in.)
24·81 mm (0·977 in.)	483·9 mm² (0·7500 sq. in.)	87·88 mm (3·46 in.)	98·80 mm (3 89 in.)	21·85 mm (0·86 in.)	109·22 mm (4·30 in.)
20·27 mm (0·798 in.)	322·6 mm² (0·5000 sq. in.)	71·63 mm (2·82 in.)	80·77 mm (3·18 in.)	17·78 mm (0·70 in.)	88·9 mm (3·50 in.)
14·32 mm (0·564 in.)	161·3 mm² (0·2500 sq. in.)	51 mm (2·00 in.)	57·15 mm (2·25 in.)	13·0 mm (0·50 in.)	64·00 mm 2.600 in.)
10·76mm (0·424 in.)	01·10 mm² (0·1412 sq. in.)	38 mm (1·5 in.)	42·93 mm (1·69 in.)	9·4 mm (0·37 in.)	46·99 mm (1·85 in.)
10·13mm (0·399 in.)	80·65 mm² (0·1250 sq. in.)	35·81 mm (1·41 in.)	40 13 mm (1·58 in.)	8·89 mm (0·35 in.)	44·45 mm (1·75 in.)
9·07 mm (0·257 in.)	64·52 mm² (0·1000 sq. in.)	32·0 mm (1·26 in.)	36·07 mm (1·42 in.)	7·87 mm (0·31 in.)	39·37 mm (1·55 in.)
7·16 mm (0·282 in.)	40 33 mm² (0·0625 sq. in.)	25·0 mm (1·00 in.)	28·45 mm (1·12 in.)	6·35 mm (0·25 in.)	31·75 mm (1·25 in.)
5·74 mm (0·226 in.)	25·8 mm² (0 0400 sq. in.)	20·32 mm (0·80 in.)	22·86 mm (0 90 in.)	5·10 mm (0·20 i	25·0 mm (1·00 in.)
4·04 mm (0·159 in.)	12·9 mm² (0·0200 sq. in.)	14·22 mm (0 56 in.)	16·0 mm (0·63 in.)	3·56 mm (0·14 in.)	1·78 mm (0·70 in.)
3·17 mm (0 125 in.)	7 87 mm² (0 0122 sq. in.)	11·18 mm (0 44 in.)	13 0 mm (0·50 in.)	2·79 mm (0·11 in.)	13·97 mm (0·55 in.)

(254) in Appendix D, for the figures, abbreviations and words "8 tons/per sq. in.", "per inch" and "2 in." wherever they occur, the figures, abbreviations and brackets "12·6 kg./mm² 8 tons per sq. in.)", "25 mm (per inch)" and "51 mm (2 in.)" shall respectively be substituted ;

(255) in Appendix E,—

(*i*) for tables D and E, the following Tables shall be substituted, namely —

APPENDIX E

FLANGES FOR PIPES, VALVES AND FITTINGS

(For land use)

TABLE D.—*For Working Steam Pressure upto 3·5 kg/cm² (50 lbs/sq. in.)*

(This table does not apply to boiler feed pipes, or to other water pipes subject to exceptional shocks.)

TABLE E.—*For Working Steam Pressure above 3·5 kg/cm² (50 lbs/sq. in.) and upto 77 kg/cm² (100 lbs./sq. in.)*

Nominal Intl. Dia. of pipe	Diamater of Flange	Diameter of Bolt Circle	Number and diameter of Bolts (of centre lines)		Thickness of Flange				
					Cast Iron	Cast Steel and Bronze		Stamped or forged wrough Iron or Steel (see Notes)	
	Upto 3·5 kg./cm² (5 lbs. sq in). 7 kg./cm² (100 lbs./ sq. in.)	Upto 3·5 kg./cm² (5 lbs./ sq. in 7 kg./cm² (100 lbs./ sq. in.)	Upto 3·5kg./cm² (50 lbs./ sq. in.)	Upto 7 kg./cm² (100 lbs. sq. in.)	Upto 3·5 kg./cm² (50 lbs./ sq. in.) 7kg./cm² (100 lbs./ sq. in.)	Upto 3·5 kg./cm² (50 lbs./ sq. in.)	Upto 7 kg./cm² (100 lbs./ sq. in.)	Upto 3·5 kg./cm² (50 lbs./ sq. in.)	Upto 7 kg cm² (100 lbs sq. in.)
13mm (½ in.)	95 mm (3-3/4 in.)	67 mm (2-5/8 in.)	4-13 mm (½ in.)	4-13 mm (½ in.)	10 mm (3/8 in.)	10 mm (3/8 in.)	10 mm (3/8 in.)	5 mm (3/16 in.)	6 mm (1/4 in.)
19mm (¾ in.)	102 mm (4 in.)	73 mm (2-7/8 in.)	4-13 mm (½ in.)	4-13 mm (¾ in.)	13 mm (½ in.)	10 mm (3/8 in.)	10 mm (3/8 in.)	5 mm (3/16 in.)	6 mm (1/4 in.)
25 mm (1 in.)	114 mm (4½ in.)	83 mm (3-1/4 in.)	4-13 mm (gin.)	4-13 mm (¾ in.)	13 mm (½ in.)	10 mm (3/8 in.)	10 mm (3/8 in.)	5 mm (3/16 in.)	7 mm (9/32 in.)
32 mm (1¼ in.)	121 mm (4-3/4 in.)	87 mm (3-7/16 in.)	4-13 mm (½ in.)	4-13 mm (½ in.)	(16 mm (5/8 in.)	13 mm (½ in.)	13 mm (½ in.)	6 mm (1/4 in.)	8 mm (5/16 in.)
38 mm (1½ in.)	133 mm (5-1/4 in.)	98 mm (3⅜ in.)	4-13 mm (½ in.)	4-13 mm (½ in.)	16 mm 5/8 in.)	13 mm (½ in.)	13 mm (½ in.)	6 mm (1/4 in.)	8·8 mm (11/32 in.)
51 mm (2 in.)	152 mm (6 in.)	114 mm (4½ in.)	4-16 mm (5/8 in.)	4-16 mm (5/8 in.)	19 mm (3/4 in.)	14·5 mm (9/16 in.)	14 5 mm (9/16 in.)	8 mm (5/16 in.)	10 mm (3'8 in.)
64 mm (2½in.)	165 mm (6½ in.)	127 mm (5 in.)	4-16 mm (5'8 in.)	4-16 mm (5'8 in.)	19 mm (3/4 in.)	14·5 mm (9'16 in.)	14·5 mm (9/16 in.)	8 mm (5'16 in.)	10·5 mm (13'32 in.)
76 mm (3 in.)	184 mm (7-1/4 in.)	146 mm 5-3/4 in.)	4-16 mm (5/8 in.)	4-16 mm (5'8 in.)	19 mm (3/4 in.)	14 5 mm (9'16 in.)	14·5 mm (9 16 in.)	10 mm (3 8 in.)	11 mm (7/16 in.)
89 mm (3½ in.)	203 mm (8 in.)	165 mm (6-1 2 in.)	4-16 mm (5/8 in.)	4-16 mm (5 8 in.)	19 mm (3/4 in.)	14·5 mm (9'16 in.)	14 5 mm (9/16 in.)	10 mm (3'8 in.)	12·8 mm (15/32 in.)
102 mm (4 in.)	216 mm (8½ in.)	178 mm (7 in.)	4-16 mm (5/8 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	17·5 mm (11/16 in.)	17·5 mm (11/16 in.)	10 mm (3'8 in.)	13 mm (½ in.)

14 mm (4½ in.)	229 mm (9 in.)	191 mm (7½ in.)	8-16 mm (5/8 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	17·5 mm (11/16 in.)	17·5 mm (11/16 in.)	11 mm (7/16 in.)	13 mm (½ in.)
127 mm (5 in.)	254 mm (10 in.)	216 mm (8½ in.)	8-16 mm (5/8 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	17·5 mm (11/16 in.)	17·5 mm (11/16 in.)	13 mm (½ in.)	14·5 mm (9/16 in.)
152 mm (6 in.)	279 mm (11 in.)	235 mm (9 in.)	8-16 mm (5/8 in.)	8-19 mm (3/4 in.)	22 mm (7/8 in.)	17·5 mm (11/16 in.)	17·5 mm (11/16 in.)	13 mm (½ in.)	17·5 mm (11/16 in.)
178 mm (7 in.)	305 mm (12 in.)	260 mm (10 1/4 in.)	8-16 mm (5/8 in.)	8-19 mm (3/4 in.)	25 mm (1 in.)	19 mm (3/4 in.)	19 mm (3/4 in.)	13 mm (½ in.)	19 mm (3/4 in.)
203 mm (8 in.)	337 mm (13 1/4 in.)	292 mm (11½ in.)	8-16 mm (5/8 in.)	8-19 mm (3/4 in.)	25 mm (1 in.)	19 mm (3/4 in.)	19 mm (3/4 in.)	13 mm (1/2 in.)	19 mm (3/4 in.)
229 mm (9 in.)	368 mm (14½ in.)	324 mm (12-3/4 in.)	8-16 mm (5/8 in.)	12-19 mm (3/4 in.)	25 mm (1 in.)	19 mm (3/4 in.)	20·5 mm (13/16 in.)	16 mm (⅝ in.)	20·5 mm (13/16in.)
254 mm (10 in.)	406 mm (16 in.)	356 mm (14 in.)	8-19 mm (3/4 in.)	12-19 mm (3/4 in.)	25 mm (1 in.)	19 mm (3/4 in.)	22 mm (7/8 in.)	16 mm (⅝ in.)	22 mm (7/8 in.)
*279 mm (11 in.)	432 mm (17 in.)	381 mm (18 in.)	8-19 mm (3/4 in.)	12-19 mm (3/4 in.)	29 mm (1-1/8 in.)	22 mm (7/8 in.)	23·6 mm (15/16 in.)	16 mm (⅝ in.)	23·5 mm (15/16 in.)
305 mm (12 in.)	457 mm (18 in.)	406 mm (16 in.)	13-19 mm (3/4 in.)	12-22 mm (7/8 in.)	29 mm (1-1/8 in.)	22 mm (7/8 in.)	25 mm (1 in.)	16 mm (⅝ in.)	25 mm (1 in.)
*330 mm (13 in.)	489 mm (19-1/4 in.)	438 mm (17-1/4 in.)	12-19 mm (3/4 in.)	12-22 mm (7/8 in.)	29 mm (1-1/8 in.)	22 mm (7/8 in.)	25 mm (1 in.)	19 mm (3/4 in.)	25 mm (1 in.)
356 mm (14 in.)	527 mm (20-3/4 in.)	470 mm (18½ in.)	12-22 mm (7/8 in.)	12-22 mm (7/8 in.)	32 mm (1-1/4 in.)	25 mm (1 in.)	25 mm (1 in.)	19 mm (3/4 in.)	25 mm (1 in.)
381 mm (15 in.)	552 mm (21-3/4 in.)	495 mm (19½ in.)	12-22 mm (7/8 in.)	12-22 mm (7/8 in.)	32 mm (1-1/4 in.)	25 mm (1 in.)	25 mm (1 in.)	19 mm (3/4 in.)	25 mm (1 in.)
406 mm (16 in.)	578 mm (22-3 4in.)	521 mm (20½ in.)	12-22 mm (7/8 in.)	12-22 mm (7/8 in.)	35 mm (1-3/8 in.)	29 mm (1-1/8 in.)	29 mm (1-1/8 in.)	22 mm (7/8 in.)	29 mm (1-1/8 in.)
*432 mm (17 in.)	610 mm (24 in.)	552 mm (21-3/4in.)	12-22 mm (7/8 in.)	16-22 mm (7/8 in.)	35 mm (1-3/8 in.)	29 mm (1-1/8 in.)	29 mm (1-1/8 in.)	22 mm (7/8 in.)	29 mm (1-1/8 in.)
*457 mm (18 in.)	641 mm (25 1.4 in.)	584 mm (23 in.)	12-22 mm (7/8 in.)	16-22 mm (7/8 in.)	35 mm (1-3/8 in.)	29 mm (1-1/8 in.)	32 mm (1-1/4 in.)	22 mm (7/8 in.)	32 mm (1-1/4 in.)
*483 mm (19 in.)	673 mm (26½ in.)	610 mm (24 in.)	12-22 mm (7/8 in.)	16-22 mm (7/8 in.)	38 mm (1½ in.)	32 mm (1-1/4 in.)	32 mm (1-1/4 in.)	25 mm (1 in.)	32 mm (1-1/4 in.
508 mm (20 in.)	705 mm (27-3/4 in.)	641 mm (25-3/4 in.)	16-22 mm (7/8 in.)	16-25 mm (1 in.)	38 mm (1½ in.)	32 mm (1-1/4 in.)	35 mm (1 3/8 in.)	25 mm (1 in.)	35 mm (1-1/4 in.
533 mm (21 in)	737 mm (29 in.)	672 mm (26 ½in.)	16-22 mm (7/8 in.)	16-25 mm (1 in.)	38 mm (1½ in.)	32 mm (1-1/4 in.)	35 mm (1-3/8 in.)	25 mm (1 in.)	35 mm (1-3/8 in.
*559 mm (22 in.)	762 mm (30 in.)	699 mm (27½ in.)	16-25 mm (1 in.)	16-25 mm (1 in.)	41 mm (1-5/8 in.)	35 mm (1-3/8 in.)	35 mm (1-3/8 in.)	29 mm (1-1/8 in.)	35 mm (1-3/8 in.
*584 mm (23 in.)	787 mm (31 in.)	724 mm (28¼ in.)	16-25 mm (1 in.)	16-25 mm (1 in.)	41 mm (1-5/8 in.)	35 mm (1-3/8 in.)	38 mm (1½ in.)	29 mm (1/8 in.)	38 mm (1½ in.
610 mm (24 in.)	826 mm (30½ in.)	756 mm (29 3/4 in.)	16-25 mm (1 in.)	16-25 mm (1 in.)	41 mm (1-5/8 in.)	35 mm (1-3/8 in.)	38 mm (1½ in.)		

*See Notes at end of Tables regarding these, also for other particulars.

(*n*) for Tables F and H, the following Tables shall be substituted, namely —

TABLE F.—*For Working Steam Pressures above 7 kg/cm² (100 lbs/sq. in.) and upto 10·5 kg/cm² (150 lbs/sq. in.)*

TABLE H.—*For Working Steam Pressures above 10·5 kg/cm² (150 lbs/sq. in.) and upto 17·5 kg/cm² (250 lbs/sq. in.)*

Nominal Internal Diameter of Pipe	Diameter of Flange	Diameter of Bolt Circle	Number and Diameter of Bolts (off centre lines		Thicknews at Flange		
					Cast iron	Cast Steel and Bronze Steel (stamped or forged)(see notes	
	Upto 10·5 kg/cm² (150 lbs/sq in. 17·5kg./cm² (250 lbs/sq. in.)	Upto 10·5 kg/cm² (150 lbs/sq. in.) 17·5 kg/cm² (250 lbs/sq. in.)	Upto 10·5 kg/cm² (150 lbs/sq. in.)	Upto 17·5 kg/cm² (250 lbs/sq in.	Upto 10·5 kg/cm² (150 lbs/sq. in.)	Upto 10·5 kg/cm² (150 lbs/sq. in.)	Upto 17·5 kg/cm² (250 lbs/sq in.)
1	2	3	4	5	6	7	8
10·5 kg/cm² (150 lbs/sq in.) only — 13 mm (½ in.)	95 mm (3-3/4 in.)	67 mm (2-5/8 in.)	4-13mm (½ in.)	4-16mm (5/8 in.)	13mm (1/2 in.)	10 mm (3/8 in.)	..
10·5 kg/cm² (150 lbs/sq in.) only — 19 mm (3/4 in.)	102 mm (4 in.)	73 mm (2-7/8 in.)	4-13 mm (½ in.)	4-16 mm (5/8 in.)	13mm (1/2 in.)	10 mm (3/8 in.)	..
17·5 kg/cm² (250 lbs sq. in.) — 13 mm (1/2 in.)	114 mm (4½ in.)	83 mm (3-1/4 in.)	..	4-16 mm (5/8 in.)		..	..
17·5 kg/cm² (250 lbs sq. in.) — 19 mm (3/4 in.)	114 mm (4-1/2 in.)	83 mm (3-1/4 in.)		4-16 mm (5/8 in.)		.	13 mm (1/2 in.)
25 mm (1 in.)	121 mm (4 3/4 in.)	87 mm (3-7/16 in.)	4-16 mm (5/8 in.)	4-16 mm (5/8 in.)	13 mm (1/2 in.)	10 mm (3/8 in.)	14·5 mm (9/16 in.)
32 mm (1-1/4 in.)	133 mm (5¼ in.)	98 mm (3-7/8 in.)		4-16 mm (5/8 in.)	16 mm (5/8 in.)	11 mm (7/16 in.)	17·5 mm (11/16 in.)
38 mm (1-1/2 in.)	140 mm (5½ in.)	105 mm (4-1/8 in.)		4-16 mm (5/8 in.)	16 mm (5/8 in.)	13 mm (1/2 in.)	17·5 mm (11/16 in.)
51 mm (2 in.)	155 mm (6-1/2 in.)	127 mm (5 in.)		4-16 mm (5/8 in.)	19 mm (3/4 in.)	16 mm (5/8 in.)	19 mm (3/4 in.)

64mm (2-1/2 in.)	184 mm (7-1/4 in.)	146 mm (5-3/4 in.)	8-16 mm (5/8 i...)	19 mm (3/4 in.)	16 mm (5/8 in.)	19 mm (3/4 in.)
76 mm (3 in.)	203 mm (8 in.)	165 mm (6-1/2 in.)	8-16 mm (5/8 i...)	19 mm (3/4 in.)	16 mm (5/8 in.)	22 mm (7/8 in.)
89 mm (3-1/2 in.)	216 mm (8-1/2 in.)	178 mm (7 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	19 mm (3/4 in.)	22 mm (7/8 in.)
102 mm (4 in.	229 mm (9 in.)	191 mm (7-1/2 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	19 mm (3/4 in.)	25 mm (1 in.)
114 mm (4-1/2 in.)	254 mm (10 in.)	210 mm (8/4 in.)	8-16 mm (5/8 in.)	22 mm (7/8 in.)	19 mm (3/4 in.)	25 mm (1 in.)
127 mm (5 in.)	279 mm (11 in.)	235 mm (9-1/4 in.)	8-19 mm (5/8 in.)	25 mm (1 in.)	22 mm (7/8 in.)	29 mm (1-1/8 in.)
152 mm (6 in.	305 mm (12 in.)	260 mm (10-1/4 in.	12-19 mm (1/2 in.	25 mm (1 in.)	22 mm (7/8 in.)	29 mm (1-1/8 in.)
178 mm (7 in.	337 mm (13-1/4 in.)	292 mm (11-1/2 in.)	12-19 mm (1/2 in.	25 mm (1 in.)	22 mm (7/8 in.)	32 mm (1-1/4 in.)
203 mm (8 in.)	368 mm (14-1/2 in.)	324 mm (12-3/4 in.)	12-19 mm (1/2 in.	29 mm (1-1/8 in.)	25 mm (1 in.)	32 mm (1-1/4 in.)
229 mm (9 in.)	406 mm (16 in.)	356 mm (14 in.)	12-22 mm (1/2 in.	29 mm (1-1/8 in.)	25 mm (1 in.)	35 mm (1-3/8 in.)
254 mm (10 in.)	432 mm (17 in.)	381 mm (15 in.)	12-22 mm (1/2 in.	29 mm (1-1/8 in.)	25 mm (1 in.	35 mm (1-3/8 in.)
279 mm (11 in.	457 mm (18 in.)	406 mm (16 in.)	16-22 mm (5/8 in.	32 mm (1-1/4 in.)	29 mm (1-1/8 in.)	38 mm (1-1/2 in.)
305 mm (12 in.)	489 mm (19-1/4 in.	438 mm (17-1/4 in.)	16-22 mm (5/8 in.	32 mm (1-1/4 in.)	29 mm (1-1/8 in.)	38 mm (1-1/2 in.)
330 mm (13 in.)	527 mm (20-3/4 in.)	470 mm (18-1/2 in.)	16-25 mm (1/2 in.	32 mm (1-1/4 in.)	29 mm (1-1/8 in.)	41 mm (1-5/8 in.)
356 mm (14 in.)	552 mm (21-3/4 in.)	495 mm (19-1/2 in.)	16-25 mm (1/2 in.	35 mm (1-3/8 in.)	32 mm (1-1/4 in.)	41 mm (1-5/8 in.)

1	2	3	4 5	6	7	8
381 mm (15 in.)	578 mm (22-3/4 in.)	521 mm (20-1/2 in.)	16-25 mm (1 in.)	35 mm (1-3/8 in.)	32 mm (1-1/4 in.)	44 mm (1-3/4 in.)
406 mm (16 in.)	610 mm (24 in.)	552 mm (21-3/4 in.)	20-25 mm (1 in.)	35 mm (1-3/8 in.)	32 mm (1-1/4 in.)	44 mm (1-3/4 in.)
*432 mm (17 in.)	641 mm (25-1/4 in.)	584 mm (23 in.)	20-25 mm (1 in.)	38 mm (1-1/2 in.)	35 mm (1-3/8 in.)	48 mm (1-7/8 in.)
457 mm (18 in.)	673 mm (26-1/2 in.)	610 mm (24 in.)	20-29 mm (1-1/8 in.)	38 mm (1-1/2 in.)	35 mm (1-3/8 in.)	48 mm (1-7/8 in.)
*483 mm (19 in.) . .	705 mm (27-3/4 in.)	641 mm (25-1/2 in.)	20-29 mm (1-1/8 in.)	38 mm (1-1/2 in.)	35 mm (1-3/8 in.)	51 mm (2 in.)
508 mm (20 in.) . .	737 mm (29 in.)	673 mm (26-1/2 in.)	24-29 mm (1-1/8 in.)	41 mm (1-5/8 in.)	38 mm (1-1/2 in.)	51 mm (2 in.)
533 mm (21 in.) . .	762 mm (30 in.)	699 mm (27-1/2 in.)	24-29 mm (1-1/8 in.)	41 mm (1-5/8 in.)	38 mm (1-1/2 in.)	54 mm (2-1/8 in.)
*559 mm (22 in.) . .	787 mm (31 in.)	724 mm (28-1/2 in.)	24-29 mm (1-1/8 in.)	41 mm (1-5/8 in.)	38 mm (1-1/2 in.)	54 mm (2-1/8 in.
*584 mm (23 in.) . .	826 mm (32-1/2 in.)	756 mm (29-3/4 in.)	24-32 mm (1-1/4 in.)	41 mm (1-3/4 in.)	41 mm (1-5/8 in.)	57 mm (2-1/4 in.)
610 mm (24 in.) . .	851 mm (33½ in.)	781 mm (30-3/4 in.)	24-32 mm (1-1/4 in.)	44 mm (1-3/4 in.)	41 mm (1-5/8 in.)	57 mm (2-1/4 in.)

See Notes at the end of Tables regarding these, also for flanges for pipe lines and other particulars.

Table For Working Steam Pressure above 17·5 kg/cm² (250 lbs./sq. in.) and upto 24·5 kg/cm. (350 lbs./sq. in.).

Nominal Int. Dia. of pipe.	Actual Extl. Dia. of Wrought Pipe	Diameter of Flange	Diameter of Bolt Circle	Number and Diameter of Bolts (off centre lines)	Thickness of flange
					Cast steel and Bronze; steel (stamped or forged) (See Notes)
1	2	3	4	5	6
13 mm (1/2 in.)	21 4 mm (27/32 in.)	114 mm (4-1/2 in.)	83 mm (3-1/4 in.)	4-16 mm (5/8 in.)	16 mm (5/8 in.)
19 mm (3/4 in.)	27 mm (1-1/16 in.)	114 mm (4-1/2 in.)	83 mm (3-1/4 in.)	4-16 mm (5 8 in.)	16 mm (5/8 in.)
25 mm (1 in.)	34 mm (1-11/32 in.)	121 mm (4-3/4 in.)	87 mm (3-7/16 in.)	4-16 mm (5/8 in.)	19 mm (3/4 in.)
32 mm (1-1/4 in.)	43 mm (1-11/16 in.)	133 mm (5-1/4 in.)	98 mm (3-7/8 in.)	4-16 mm (5/8 in.)	19 mm (3/4 in.)
38 mm (1-1/2 in.)	48 mm (1-29/32 in.)	140 mm (5 -1/2 in.)	105 mm (4-1/8 in.)	4-16 mm (5/8 in.)	22 mm (7/8 in.)
51 mm (2 in.)	60 mm (2-3/8 in.)	165 mm (6-1/2 in.)	127 mm (5 in.)	4-19 mm (3/4 in.)	25 mm (1 in.)
(64 mm (2-1/2 in.)	76 mm (3 in.)	197 mm (7-3/4 in.)	146 mm (5-3/4 in.)	8-19 mm (3/4 in.)	25 mm (1 in.)
76 mm (3 in.)	89 mm (3-1/2 in.)	203 mm (8 in.)	165 mm (6-1/2 in.)	8-19 mm (3/4 in.)	32 mm (1-1/4 in.)
83 mm (3-1/4 in.)	102 mm (4 in.)	216 mm (8-1/2 in.)	178 mm (7 in.)	8-19 mm (3.4 in.)	32 mm (1-1/4 in.)
102 mm (4 in.)	114 mm (4-1/2 in.)	229 mm (9 in.)	191 mm (7-1/2 in.)	8-19 mm (3/4 in.)	35 mm (1-3/8 in.)
*114 mm (4-1/2 in.)	127 mm (5 in.)	254 mm (10 in)	210 mm (8-1/4 in.)	8-22 mm (7/8 in.)	35 mm (1-3/8 in.)
127 mm (5 in.)	140 mm (5-1/2 in.)	279 mm (11 in.)	235 mm (9-1 4 in.)	8-22 mm (7/8 in.)	38 mm (1-1/2 in.)
152 mm (6 in.)	165 mm (6-1/2 in.)	305 mm (12 in.)	260 mm (10-1/4 in.)	12-22 mm (7/8 in.)	38 mm (1-1/2 in.)
178 mm (7 in.)	191 mm (7-1/2 in.)	337 mm (13-1/4 in.)	292 mm (11-1/2 in.)	12-22 mm (7/8 in.)	41 mm (1-5/8 in.)
203 mm (8 in.)	216 mm (8-1/2 in.)	368 mm (14-1/2 in.)	324 mm (12-3/4 in.)	12-22 mm (7/8 in.)	41 mm (1-5/8 in.)
229 mm (9 in.)	241 mm (9-1/2 in.)	406 mm (16 in.)	356 mm (14 in.)	12-25 mm (1 in.)	44 mm (1-3/4 in.)
254 mm (10 in.)	267 mm (10-1/2 in.)	432 mm (17 in.)	381 mm (15 in.)	12-25 mm (1 in.)	48 mm (1-7 8 in.)
*279 mm (11 in.)	292 mm (11-1 2 in.)	457 mm (18 in.)	406 mm (16 in.)	16-25 mm (1 in.)	48 mm (1-7 8 in.)
305 mm (12 in.)	318 mm (12-1/2 in.)	489 mm (19-3/4 in.)	451 mm (17-3/4 in.)	16-25 mm (1 in.)	51 mm (2 in.)
*330 mm (13 in.)	356 mm (14 in.)	527 mm (20-3/4 in.)	476 mm (18-3/4 in.)	16-29 mm (1-1/8 in.)	54 mm (2 in.)
356 mm (14 in.)	381 mm (15 in.)	552 mm (21-3 4 in.)	502 mm (19-3 4 in.)	16-29 mm (1-1/8 in.)	54 mm (2-1/8 in.)
381 mm (15 in.)	406 mm (16 in.)	578 mm (22-3 4 in.)	527 mm (20-3/4 in.)	16-29 mm (1-1/8 in.)	54 mm (2-1/8 in.)
406 mm (16 in.)	432 mm (17 in.)	610 mm (24 in.)	552 mm (20 in.)	20-29 mm (1-1/8 in.)	57 mm (2-1/4 in.)
*432 mm (17 in.)	457 mm (18 in.)	641 mm (25-1/4 in.)	584 mm (23 in.)	20-29 mm (1-1/8 in.)	60 mm (2-3/8 in.)
457 mm (18 in.)	483 mm (19 in.)	673 mm (26-1/2 in.)	610 mm (24 in.)	20-32 mm (1-1/4 in.)	60 mm (2-3/8 in.)
483 mm (19 in.)	508 mm (20 in.)	705 mm (27-3/4 in.)	641 mm (25-1 4 in.)	20-32 mm (1-1/4 in.)	64 mm (2-1/2 in.)
508 mm (20 in.)	533 mm (21 in.)	737 mm (29 in.)	673 mm (26-1, 2 in.)	24-32 mm (1-1/4 in.)	64 mm (2-1/2 in.)

1	2	3	4	5	6
533 mm (21 in.)	559 mm (22 in.)	762 mm (30 in.)	699 mm (27-1/2 in.)	24-32 mm (1-1/4 in.)	67 mm (2-5/8 in.)
*559 mm (22 in.)	584 mm (23 in.)	787 mm (31 in.)	724 mm (28-1/2 in.)	24-32 mm (1-1/4 in.)	67 mm (2-5/8 in.)
*584 mm (23 in.)	610 mm (24 in.)	826 mm (32 -1/2 in.)	756 mm (29-3/4 in.)	24-35 mm (1-3/8 in.)	70 mm (2-3/4 in.)
610 mm (24 in.)	635 mm (25 in.)	851 mm (33-1/2 in.)	781 mm (30-3/4 in.)	24-35 mm (1-3/8 in.)	70 mm (2-3/4 in.)

*See Notes at end of Table regarding these, also for flanges, for pipe lines and other particulars.

The actual external diameters of wrought pipes given above apply equally to all tables

(iv) for Table K, the following Table shall be substituted, namely :—

TABLE K.—*For Working Pressures above 24·5 kg/cm² (350 lbs/sq. in) and upto 31·5 kg/cm² (450 lbs/sq. in)*

National Intl. Dia. of Pipe	Actual Extl. dia. of wrought pipe	Diameter of Flange	Diameter of Bolt Circle	Number and Diameter of Bolts (off centre lines)	Thickness of flange
					Cost Steel & Bronze steel (stamped or forged) (see Notes)
13 mm (1/2 in.)	21·4 mm (27/32 in.)	114 mm (4-1/2 in.)	83 mm (3-1/4 in.)	4-16 mm (5/8 in.)	19 mm (3/4 in.)
19 mm (3/4 in.)	27 mm (1-1/16 in.)	114 mm (4-1/2 in.)	83 mm (3-1/4 in.)	4-16 mm (5/8 in.)	19 mm (3/4 in.)
25 mm (1 in.)	34 mm (1-11/32 in.)	127 mm (5 in.)	95 mm (3-3/4 in.)	4-16 mm (5/8 in.)	22 mm (7/8 in.)
32 mm (1-1/4 in.)	43 mm (1-11/16 in.)	133 mm (5-1/4 in.)	98 mm (3-7/8 in.)	4-16 mm (5/8 in.)	22 mm (7/8 in.)
38 mm (1-1/2 in.)	48 mm (1-29/32 in.)	152 mm (6 in.)	114 mm (4-1/2 in.)	4-19 mm (3/4 in.)	25 mm (1 in.)
51 mm (2 in.)	60 mm (2-3/8 in.)	165 mm (6-1/2 in.)	127 mm (5 in.)	8-16 mm (5/8 in.)	25 mm (1 in.)
64 mm (2-1/2 in.)	76 mm (3 in.)	184 mm (7-1/4 in.)	146 mm (5-3/4 in.)	8-19 mm (3/4 in.)	29 mm (1-1/8 in.)
76 mm (3 in.)	89 mm (3-1/2 in.)	203 mm (8 in.)	165 mm (6-1/2 in.)	8-19 mm (3/4 in.)	32 mm (1-1/4 in.)
89 mm (3-1/2 in.)	102 mm (4 in.)	229 mm (9 in.)	184 mm (7-1/4 in.)	8-22 mm (7/8 in.)	32 mm (1-1/4 in.)
102 mm (4 in.)	114 mm (4-1/2 in.)	241 mm (9-1/2 in.)	197 mm (7-3/4 in.)	8-22 mm (7/8 in.)	35 mm (1-3/8 in.)
*114 mm (4-1/2 in.)	127 mm (5 in.)	254 mm (10 in.)	210 mm (8-1/4 in.)	8-22 mm (7/8 in.)	38 mm (1-1/2 in.)
127 mm (5 in.)	140 mm (5-1/2 in.)	279 mm (11 in.)	235 mm (9-1/4 in.)	12-22 mm (7/8 in.)	41 mm (1-5/8 in.)
152 mm (6 in.)	165 mm (6-1/2 in.)	305 mm (12 in.)	260 mm (10-1/4 in.)	12-22 mm (7/8 in.)	41 mm (1-5/8 in.)
178 mm (7 in.)	191 mm (7-1/2 in.)	343 mm (13-1/2 in.)	292 mm (11-1/2 in.)	12-25 mm (1 in.)	44 mm (1-3/4 in.)
203 mm (8 in.)	216 mm (8-1/2 in.)	368 mm (14-1/2 in.)	318 mm (12-1/2 in.)	12-25 mm (1 in.)	48 mm (1-7/8 in.)
229 mm (9 in.)	241 mm (9-1/2 in.)	406 mm (16 in.)	356 mm (14 in.)	16-25 mm (1 in.)	51 mm (2 in.)
254 mm (10 in.)	267 mm (10-1/2 in.)	432 mm (17 in.)	381 mm (15 in.)	16-25 mm (1 in.)	51 mm (2 in.)
*279 mm (11 in.)	292 mm (11-1/2 in.)	470 mm (18-1/2 in.)	410 mm (16-1/4 in.)	16-29 mm (1-1/8 in.)	64 mm (2-1/8 in.)
305 mm (12 in.)	318 mm (12-1/2 in.)	489 mm (19-1/4 in.)	432 mm (17 in.)	16-29 mm (1-1/8 in.)	57 mm (2-1/4 in.)
*330 mm (13 in.)	356 mm (14 in.)	546 mm (21-1/2 in.)	483 mm (19 in.)	16-32 mm (1-1/4 in.)	60 mm (2-3/8 in.)
356 mm (14 in.)	381 mm (15 in.)	572 mm (22-1/2 in.)	508 mm (20 in.)	16-32 mm (1-1/4 in.)	60 mm (2-3/8 in.)
381 mm (15 in.)	406 mm (16 in.)	603 mm (23-3/4 in.)	540 mm (21-1/4 in.)	20-32 mm (1-1/4 in.)	64 mm (2-1/2 in.)
406 mm (16 in.)	432 mm (17 in.)	629 mm (24-3/4 in.)	565 mm (22-1/4 in.)	20-32 mm (1-1/4 in.)	67 mm (2-5/8 in.)

NOTES :—It is recommended that the use of sizes marked * should be avoided.

The thickness of flange given in the tables include a raised face of not more than 1·6 mm (1/16 in.) high if such be used.

For 13 mm (1/2 in.) and 16 mm (5/8 in.) bolts the diameters of the holes to be 1·6 mm (1/16 in.) larger than the diameters of the bolts, and for larger sizes of bolts 3 mm (1/8 in.)

Iron or Steel flanges (stamped or forged) may be screwed or riveted on with boss, or welded with fillet, the flanges being of steel for pressures above 10·5 kg/cm² (150 lbs/sq. in.)

Special welded on flanges (stamped or forged) for pipe lines 51 mm (2 in.) nominal diamet of pipe and upwards (without valves or fittings) are made as stated below, the flange selected in all cases being that given for the next smaller size of pipe in the corresponding table or specially state

Table L.—For working Steam Pressures upt 10·5 kg/cm² (150 lbs/sq. in.) corresponding with table F modified as above.

Table M.—For Working Steam Pressures above 10·5 kg/cm² (150 lbs/sq. in.) and upto 17·5 kg/cm² (250 lbs/sq. in.) corresponds with Table H modified as above.

Table P.—For Working Steam Pressures above 17·5 kg/cm² (250 lbs/sq. in.) and upto 24·5 kg/cm² (350 lbs/sq. in.) corresponds with Table J modified as above.

(*v*) for Table R, the following Table shall be substituted, namely :—

TABLE R.—*Flanges for Pipes, Valves and Fittings.*

For working Steam Pressures above 31·5 kg./cm.² (450 lbs/sq. in.) and upto 42 kg./cm.² (600 lbs/sq. in.)

1	1(a)	2	3	4	5	6(b)	7
Nominal pipe size	Approximate outside diameter of wrought pipe.	Diameter of flange	Diameter of bolt circle	Number of bolts	Diameter of bolts	Thickness of Flange	Diameter of jointing face
						Cast steel; steel (stamped or forged) screwed or riveted on with boss, or welded on with fillet.	
13 mm (½ in.)	21·4 mm (27/32 in.)	114 mm (4½ in.)	83 mm (3¼ in.)	4	16 mm (⅝ in.)	19 mm (¾ in.)	57 mm (2¼ in.)
19 mm (¾ in.)	27 mm (1-1/16in.)	114 mm (4½ in.)	83 mm (3¼ in.)	4	16 mm (⅝ in.)	19 mm (¾ in.)	57 mm (2¼ in.)
25 mm (1 in.)	34 mm (1-11/32in.)	127 mm (5 in.)	95 mm (3¾ in.)	4	16 mm (⅝ in.)	22 mm (⅞ in.)	64 mm (2½ in.)
32 mm (1¼ in.)	43 mm (1-11/16in.	133 mm (5¼ in.)	98 mm (3⅞ in.)	4	16 mm (⅝ in.)	22 mm (⅞ in.)	70 mm (2¾ in.)
38 mm (1½ in.)	48 mm (1-29/32in.)	152 mm (6 in.)	114 mm (4½ in.)	4	19 mm (¾ in.)	25 mm (1 in.)	76 mm (3 in.)
51 mm (2 in.)	60 mm (2⅜ in.)	165 mm (6½ in.)	127 mm (5 in.)	8	16 mm (⅝ in.)	25 mm (1 in.)	89 mm (3½ in.)
64 mm (2½ in.)	76 mm (3 in.)	184 mm (7¼ in.)	146 mm (5¾ in.)	8	19 mm (¾ in.)	29 mm (1⅛ in.)	102 mm (4 in.)
76 mm (3 in.)	89 mm (3½ in.)	203 mm (8 in.)	165 mm (6½ in.)	8	19 mm (¾ in.)	32 mm (1¼ in.)	114 mm (4½ in.)
89 mm (3½ in.)	102 mm (4 in.)	229 mm (9 in.)	184 mm (7¼ in.)	8	22 mm (⅞ in.)	32 mm (1¼ in.)	127 mm (5 in.)
102 mm (4 in.)	114 mm (4½ in.)	241 mm (9½ in.)	197 mm (7¾ in.)	8	22 mm (⅞ in.)	35 mm (1⅜ in.)	140 mm (5½ in.)
114 mm (4½ in.)	127 mm (5 in.)	254 mm (10 in.)	210 mm (8¼ in.)	8	22mm (⅞ in.)	38 mm (1½ in.)	152 mm (6 in.)
127 mm (5 in.)	140 mm (5½ in.)	279 mm (11 in.)	235 mm (9¼ in.)	12	22mm (⅞ in.)	41 mm (1⅝ in.)	165 mm (6½ in.)
152 mm (6 in.)	165 mm (6½ in.)	305 mm (12 in.)	260 mm (10¼ in.)	12	22mm (⅞ in.)	44 mm (1¾ in.)	191 mm (7½ in.)
172 mm (7 in.)	191 mm (7½ in.)	343 mm (13½ in.)	292 mm (11½ in.)	12	25 mm (1 in.)	48 mm (1⅞ in.)	222 mm (8¾ in.)
203 mm (8 in.)	216 mm (8½ in.)	368 mm (14⅝ in.)	324 mm (12¾ in.)	12	25 mm (1 in.)	51 mm (1 in.)	248 mm (9¾ in.)
229 mm (9 in.)	241 mm (9½ in.)	406 mm (16 in.)	356 mm (14 in.)	16	25 mm (1 in.)	54 mm (2⅛ in.)	273 mm (10¾ in.)
254 mm (10 in.)	267 mm (10½ in.)	432 mm (17 in.)	387 mm (15¼ in.)	16	25 mm (1 in.)	57 mm (2¼ in.)	298 mm (11¾ in.)
279 mm (11 in.)	292 mm (11½ in.)	483 mm (19 in.)	432 mm (17 in.)	16	29 mm (1⅛ in.)	60 mm (2⅜ in.)	324 mm (12¾ in.)
308 mm (12 in.)	318 mm (12½ in.)	508 mm (20 in.)	457 mm (18 in.)	16	29 mm (1⅛ in.)	64 mm (2½ in.)	349 mm (13¾ in.)
330 mm (13 in.)	356 mm (14 in.)	552 mm (21¾ in.)	495 mm (19½ in.)	16	32 mm (1¼ in.)	67 mm (2⅝ in.)	381 mm (15 in.)
356 mm (14 in.)	381 mm (15 in.)	584 mm (23 in.)	527 mm (20¾ in.)	16	32 mm (1¼ in.)	70 mm (2¾ in.)	406 mm (16 in.)
381 mm (15 in.)	406 mm (16 in.)	610 mm (24 in.)	552 mm (21¾ in.)	20	32 mm (1¼ in.)	73 mm (2⅞ in.)	432 mm (17 in.)
406 mm (16 in.)	432 in. (17 in.)	641 mm (25¼ in.)	584 mm (23 in.)	20	32 mm (1¼ in.)	76 mm (3 in.)	457 mm (18 in.)

(*vi*) for Table S, the following Table shall be substituted, namely :—

TABLE S.—*Steel Flanges for Pipes, Valves and Fittings.*

For Working Steam Pressures above 42 *kg/cm.*² (600 *lbs./sq. in.*) *upto* 63 *kg/cm.*² (900 *lbs./sq. in.*) *and temperature upto* 427C° 800°F).

1	1(a)	2	3	4	5	6	7
Nominal pipe size	Actual outside diameter of wrought pipe	Diameter of flange	Diameter of bolt circle	Number of bolts	Diameter of bolts	Thickness of flange	Diameter of jointing face
13 mm (½ in.)	21·4 mm (27/32 in.)	127 mm (5 in.)	89 mm (3½ in.)	4	19 mm (¾ in.)	22 mm (⅞ in.)	51 mm (2 in.)
19 mm (¾ in.)	27 mm (1-1/16 in.)	127 mm (5 in.)	89 mm (3½ in.)	4	19 mm (¾ in.)	22 mm (⅞ in.)	51 mm (2 in.)
25 mm (1 in.)	34 mm (1-11/32 in.)	140 mm (5½ in.)	102 mm (4 in.)	4	19 mm (¾ in.)	25 mm (1 in.)	57 mm (2¼ in.)
32 mm (1¼ in.)	43 mm (1-11/16 in.)	146 mm (5¾ in.)	108 mm (4¼ in.)	4	19 mm (¾ in.)	29 mm (1⅛ in.)	64 mm (2½ in.)
38 mm (1½ in.)	48 mm (1-29/32 in.)	159 mm (6¼ in.)	121 mm (4¾ in.)	4	19 mm (¾ in.)	29 mm (1⅛ in.)	70 mm (2¾ in.)
51mm (2 in.)	60 mm (2⅜ in.)	171 mm (6¾ in.)	133 mm (5¼ in.)	8	19mm (¾ in.)	32 mm (1¼ in.)	83 mm (3¼ in.)
64 mm (2½ in.)	76 mm (3 in.)	184 mm (7¼ in.)	146 mm (5¾ in.)	8	19 mm (¾ in.)	32 mm (1¼ in.)	95 mm (3¾ in.)
76 mm (3 in.)	89 mm (3½ in.)	203 mm (8 in.)	165 mm (6½ in.)	8	22 mm (⅞ in.)	35 mm (1⅜ in.)	108 mm (4¼ in.)
89 mm (3½ in.)	102 mm (4 in.)	235 mm (9¼ in.)	191 mm (7½ in.)	8	22 mm (⅞ in.)	38 mm (1½ in.)	121 mm (4¾ in.)
102 mm (4 in.)	127 mm (5 in.)	248 mm (9¾ in.)	203 mm (8 in.)	8	25 mm (1 in.)	41 mm (1⅝ in.)	133 mm (5¼ in.)
114 mm (4½ in.)	140 mm (5½ in.)	267 mm (10½ in.)	216 mm (8½ in.)	8	25 mm (1 in.)	41 mm (1⅝ in.)	146 mm (5¾ in.)
127 mm (5 in.)	152 mm (6 in.)	286 mm (11¼ in.)	235 mm (9¼ in.)	12	22mm (⅞ in.)	44 mm (1¾ in.)	159 mm (6¼ in.)
152 mm (6 in.)	178 mm (7 in.)	324 mm (12¾ in.)	273 mm (10¾ in.)	12	25 mm (1 in.)	51 mm (2 in.)	184 mm (7¼ in.)
178 mm (7 in.)	216 mm (8½ in.)	375 mm (14¾ in.)	318 mm (12½ in.)	12	29 mm (1⅛ in.)	57 mm (2¼ in.)	216 mm (8½ in.)
203 mm (8 in.)	241 mm (9½ in.)	413 mm (16¼ in.)	356 mm (14 in.)	12	32 mm (1¼ in.)	64 mm (2½ in.)	241 mm (9½ in.)
229 mm (9 in.)	267 mm (10½ in.)	438 mm (17¼ in.)	387 mm (15 ¼in.)	16	29 mm (1⅛ in.)	67 mm (2⅝ in.)	267 mm (10½ in.)
254 mm (10 in.)	292 mm (11½ in.)	483 mm (19 in.)	425 mm (16¾ in.)	16	32 mm (1¼ in.)	73 mm (2⅞ in.)	292 mm (11½ in.)
267 mm (10½ in.)	318 mm (12½ in.)	533 mm (21 in.)	470 mm (18½ in.)	16	35 mm (1⅜ in.)	79 mm (3⅛ in.)	324 mm (12¾ in.)
298 mm (11¾ in.)	356 mm (14 in.)	578 mm (22¾ in.)	508 mm (20 in.)	16	38 mm (1½ in.)	83 mm (3¼ in.)	349 mm (13¾ in.
*321 mm (12⅝ in.)	381 mm (15 in.)	610 mm (24 in.)	540 mm (21¼ in.)	16	38 mm (1½ in.)	89 mm (3½ in.)	375 mm (14¾ in.)
*348 mm (13¾ in.)	406 mm (16 in.)	648 mm (25½ in.)	578 mm (22¾ in.)	20	38 mm (1½ in.)	95 mm (3¾ in.)	406 mm (16 in.)
*365 mm (14⅜ in.)	432 mm (17 in.)	699 mm (27½ in.)	632 mm (24⅞ in.)	20	41 mm (1⅝ in.)	102 mm (4 in.)	432 mm (17 in.)
*387 mm (15¼ in.)	457 mm (18 in.)	743 mm (29¼ in.)	711 mm (26 in.)	20	44 mm (1¾ in.)	108 mm (4¼ in.)	457 mm (18 in.)

*The sizes shall be specified by the outside diameter dimensions given in column 1(a) The figures in column 1 (nominal bore) are approximate and are given for information only.

for [illegible] the [illegible]g able shall be substituted, namely :—

TABLE T—*Steel Flanges for Pipes, Valves and Fittings.*

(To be used in conjunction with the Notes and Appendices)

(For Working Steam Pressures above 63 *kg/cm²* (900 *lbs/sq. in.) and upto* 98 *kg/cm²* (14*kg lbs/sq. in.) and temperatures upto* 427°*C* (800°*F)*

Nominal pipe bore	Minimum outside diameter of wrought pipe	Diameter of flange	Diameter of bolt circle	No. of bolts	Diameter of bolts	Thickness of flange	Diameter of jointing face
13 mm	214 mm	140 mm	102 mm	4	19 mm	25 mm	57 mm
(½ in.)	(27/32 in.)	(5½ in.)	(4 in.)		(¾ in.)	(1 in.)	(2¼ in.)
10 mm	27 mm	140 mm	102 mm	4	19 mm	25 mm	57 mm
(⅜ in.)	(1-1/16 in.)	(5½ in.)	(4 in.)		(¾ in.)	(1 in.)	(2¼ in.)
25 mm	34 mm	146 mm	108 mm	4	19 mm	29 mm	64 mm
(8 in.)	(1-11 32 in.)	(5¾ in.)	(4¼ in.)		(¾ in.)	(1⅛ in.)	(2½ in.)
32 mm	43 mm	159 mm	121 mm	4	22 mm	32 mm	70 mm
(1¼ in.)	(1-11/16 in.)	(6¼ in.)	(4¾ in.)		(⅞ in.)	(1¼ in.)	(2¾ in.)
38 mm	60 mm	171 mm	133 mm	8	19 mm	35 mm	76 mm
(1½ in.)	(2⅜ in.)	(6¾ in.)	(5¼ in.)		(¾ in.)	(1⅜ in.)	(3 in.)
51 mm	76 mm	184 mm	146 mm	8	19 mm	35 mm	89 mm
(2 in.)	(3 in.)	(7¼ in.)	(5¾ in.)		(¾ in.)	(1⅜ in.)	(3½ in.)
64 mm	89 mm	203 mm	165 mm	8	22 mm	41 mm	114 mm
(2½ in.)	(3½ in.)	(8 in.)	(6½ in.)		(⅞ in.)]	(1⅝ in.)	(4½ in.)
76 mm	102 mm	235 mm	191 mm	8	25 mm	48 mm	127 mm
(3 in.)	(4 in.)	(9¼ in.)	(7½ in.)		(1 in.)	(1⅞ in.)	(5 in.)
89 mm	114 mm	267 mm	216 mm	8	29 mm	54 mm	140 mm
(3½ in.)	(4½ in.)	(10½ in.)	(8½ in.)		(1⅛ in.)	(2⅛ in.)	(5½ in.)
102 mm	127 mm	286 mm	235 mm	8	29 mm	57 mm	152 mm
(4 in.)	(5 in.)	(11¼ in.)	(9¼ in.)		(1⅛ in.)	(2¼ in.)	(6 in.)
114 mm	140 mm	298 mm	254 mm	12	25 mm	60 mm	165 mm
(4½ in.)	(5½ in.)	(11¾ in.)	(10 in.)		(1 in.)	(2⅜ in.)	(6½ in.)
127 mm	165 mm	324 mm	273 mm	12	29 mm	67 mm	178 mm
(5 in.)	(6½ in.)	(12¾ in.)	(10¾ in.)		(1⅛ in.)	(2⅝ in.)	(7 in.)
152 mm	191 mm	375 mm	318 mm	12	32 mm	73 mm	203 mm
(6 in.)	(7½ in.)	(14¾ in.)	(12½ in.)		(1¼ in.)	(2⅞ in.)	(8 in.)
178 mm	229 mm	432 mm	368 mm	12	35 mm	83 mm	235 mm
(7 in.)	(9 in.)	(17 in.)	(14½ in.)		(1⅜ in.)	(3¼ in.)	(9¼ in.)
202 mm	267 mm	476 mm	406 mm	12	38 mm	89 mm	267 mm
(8 in.)	(10½ in.)	(18¾ in.)	(16 in.)		(1½ in.)	(3½ in.)	(10½ in.)
229 mm	292 mm	508 mm	445 mm	16	35 mm	95 mm	298 mm
(9 in.)	(11½ in.)	(20 in.)	(17½ in.)		(1⅜ in.)	(3¾ in.)	(11¾ in.)
254 mm	318 mm	459 mm	489 mm	16	38 mm	108 mm	324 mm
(10 in.)	(12½ in.)	(22 in.)	(19¼ in.)		(1½ in.)	(4¼ in.)	(12¾ in.)

(viii) under heading "Standard Pipe Flanges" for the figures, symbol and abbreviations "800°F" in the two places where they occur, "900°F" and "450°F" the figures, symbols, abbreviations and brackets "400°C (800°F)", "482°C (900°F)" and "232°C (450°F)" shall respectively be substituted; and for the Table below these, the following Table shall be substituted, namely :—

Table showing the permissible application of pipe flanges tables.

Pressure	Steam at 482°C (900°F)	Steam at 427°C (800°F)	Water at 232°C (450°F)	Hydraulic Test Pressure
	Table	Table	Table	
68 kg/cm² (1400 lbs/sq. in.) .	..	T	S	196 kg/cm² (2800 lbs/sq. in.)
63 kg/cm² (900 lbs/sq. in.) .	T	S	R	126 kg/cm² (1800 lbs/sq. in.)
42 kg/cm²(600 lbs/sq. in.) .	S	R	K	84 kg/cm² (1200 lbs/sq. in.)
31·5 kg/cm²(450 lbs/sq. in.).	R	K	J	63 kg/cm² (900 lbs/sq. in.)
24.5 kg/cm²(350 lbs/sq. in.) .	K	J	H	49 kg/cm² (700 lbs/sq. in.)
17·5 kg/cm²(250 lbs/sq. in.) .	J	H	F	35 kg/cm² (500 lbs/sq. in.)
10.5 kg/cm²(150 lbs/sq. in.) .	H	F	..	21 kg/cm² (300 lbs/sq. in.)

(256) Under Appendix F, for the Table headed,
"Factors X for converting.....K×3·472", the following Table shall be substituted, namely:—

Factors X for converting Actual Breaking Loads into Equivalent Breaking Loads on Bars of Standard Diameter.

(Equivalent Breaking Load on Bar of Standard Diameter=X x Actual Breaking Load.)

and

Factors K and K_1 for converting Actual Breaking Loads into Transverse Rupture Stresses.
(Transverse Rupture Stress in kg/mm² = K_1 × actual Breaking Load in Kgs.,

or

Transverse Rupture Stress in tons/sq.in.=K×Actual Breaking Load in lbs.)

Factor K_1 =K×3·472.

15·24 mm (0·6 in.) Test Bar				22·125mm (0·875in.) Test Bar				30·48mm (1·2in.) Test Bar 40·6				mm (1·6 in.) Test Bar				53·3mm Test (2·1 in.) Bar			
Diameter		X	K	Diameter		X	K	Diameter		X	K	Diameter		X	K	Diameter		X	K
mm	in.			mm	in.			mm	in.			mm	in.			mm	in.		
..	..	..	..	..	..	..	..	..	..	..	..	38·1	1·50	1·214	0·00606	50·80	2·00	1·58	0·00341
..	..	..	..	..	..	..	..	28·23	1·11	1·264	0·0150	38·35	1·51	1·190	0·00594	51·05	2·01	1·140	0·00336
..	..	..	..	..	..	..	..	28·48	1·12	1·230	0·0146	38·60	1·52	1·166	0·00583	51·30	2·02	1·124	0·00331
..	..	..	..	20·50	0·81	1·261	0·0257	28·73	1·13	1·198	0·0142	38·85	1·53	1·144	0·00571	51·55	2·03	1·107	0·00326
..	..	..	..	20·75	0·82	1·215	0·0247	28·98	1·14	1·166	0·0138	39·10	1·54	1·121	0·00560	51·80	2·04	1·091	0·00321
..	..	..	..	21·00	0·83	1·172	0·0239	29·23	1·15	1·136	0·0135	39·35	1·55	1·100	0·00549	52·05	2·05	1·0750	0·00317
14·24	0·56	1·230	0·0582	21·25	0·84	1·130	0·0230	29·48	1·16	1·107	0·0131	39·60	1·56	1·079	0·00539	52·30	2·06	1·0590	0·00312
14·49	0·57	1·166	0·0552	21·50	0·85	1·091	0·0222	29·73	1·17	1·079	0·0128	39·85	1·57	1·058	0·00529	52·55	2·07	1·044	0·00308
14·74	0·58	1·107	0·0524	21·75	0·86	1·053	0·0214	29·98	1·18	1·052	0·0125	40·10	1·58	1·038	0·00519	52·80	2·08	1·029	0·00303
14·99	0 59	1·052	0·0498	22·00	0·87	1·017	0·207	30·23	1·19	1·025	0·0121	40·35	1·59	1·019	0·00509	53·05	2·09	1·014	0·00299
15·24	0·60	1·000	1·0474	22·125	0·875	1·000	0·0204	30·48	1·20	1·000	0·0118	40·6	1·60	1·000	0·00499	53·30	2·10	1·000	0·00295
15·49	0·61	0·952	0·0451	22·25	0·88	0·983	0·0200	30·73	1·21	0·975	0·0115	40·85	1·61	0·981	0·00490	53·55	2·11	0·986	0·00290
15·74	0·62	0·906	0·0429	22·50	0·89	0·950	0·0193	30·98	1·22	0·952	0·0113	41·10	1·62	0·963	0·00481	53·80	2·12	0·972	0·00286
15·99	0·63	0·864	0·0409	22·75	0·90	0·919	0·0187	31·23	1·23	0·929	0·0110	41·35	1·63	0·946	0·00472	54·05	2·13	0·958	0·00282
16·24	0·64	0·824	0·0390	23·00	0·91	0·889	0·0181	31·48	1·24	0·906	0·0107	41·60	1·64	0·929	0·00464	54·30	2·14	0·945	0·00278
..	..	..	..	23·25	0·92	0·860	0·0175	31·73	1·25	0·885	0·0105	41·85	1·65	0·912	0·00455	54·55	2·15	0·932	0·00274
..	..	..	..	23·50	0·93	0·833	0·0170	31·98	1·26	0·864	0·0102	42·10	1·66	0·895	0·00447	54·80	2·16	0·919	0·00271
..	..	..	..	23·75	0·94	0·807	0·0164	32·23	1·27	0·844	0·0100	42·35	1·67	0·879	0·00439	55·05	2·17	0·906	0·00267
..	..	..	..	..	..	..	..	32·48	1·28	0·824	0·0098	42·60	1·68	0·864	0·00431	55·30	2·18	0·894	0·00263
..	..	..	..	..	..	..	..	32·73	1·29	0·805	0·00095	42·85	1·69	0·849	0·00424	55·55	2·19	0·882	0·00260
..	..	..	..	..	..	..	..	..	..	..	..	43·10	1·70	0·834	0·00416	55·80	2·20	0·870	0·00253

(257) In Regulation 537, for the figures and words "32 tons per square inch", the following figures, words, abbreviations and brackets shall be substituted, namely,—

"50 kg/ mm² (32 tons/sq. in.)"

(258) In Regulation 541, for the figures and words "1/8 inch" and "3/16 inch" the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"3 mm (1/8 in.)"

"5 mm (3/16 in.)'

(259) In Regulation 544, for the Table XII/1, the following table shall be substituted, namely,—

TABLE XII/1. Maximum percentage departure from designed form of welded boilers.

Nominal internal diameter of boiler D	Maximum departure from designed from per cent of D)
Upto and including 914 mm (36 in.)	0·375
Over 914 mm. upto and including 1143 mm (45 in.)	0·350
Over 1143 mm.	0·300

(260) In Regulation 546, for the figures and words "¼ inch, 12 inches" the following figures words, abbreviations and brackets shall respectively be substituted, namely,

"6 mm (¼ in.)

305 mm (12 in.)"

(261) In Regulation 547, for the figures and words, "¼ inch, 3 feet, 3/8 inch, 1½ inch, per foot, 2 inches, 2 feet and 6 inches, 2½ inches", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"6 mm (¼ in.)

914 mm (3 ft.)

10 mm (3/8 in.)

38 mm (1½ in.)

per 305 mm (foot)

51 mm (2 in.)

762 mm (2 ft. and 6 in.)

64 mm (2½ in.)"

(262) In Regulation 548, for the figure and word "1 inch", the following figures, words abbreviations and brackets shall be substituted, namely,—

"25 mm (1 in.)"

(263) In Regulation 549, for the figures and words, "¼ inch, 5/8 inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"6 mm (¼ in.)

16 mm (5/8 in.)"

(264) In Regulation 550,

(i) in clause (b), for the figure and words "not less than 11 threads per inch", the following figures, words, abbreviations and brackets shall be substituted, namely,
"of pitch not less than 2·5 mm (not less than 11 threads per inch)"

(ii) for the figures and words "14 inches, 3/16 inch, ¼ inch" the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"356 mm (14 in.)

5 mm (3/16 in.)

13 mm (½ in.)"

(265) In Regulation 551, for the figure and word "1½ inches", the following figures, words, abbreviations and brackets shall be substituted, namely,

"38 mm (1½ in.)"

(266) In Regulation 553, for the tables XII/2 and XII/3, the following tables shall respectively be substituted, namely,

TABLE XII/2. Dimensions of Manholes or Sight Holes

Diameter of boiler	Minimum size of hole mm.	in.
Boilers not exceeding 762 mm (2 ft. and 6 in.)	229×178	(9×7)
Boilers over 762 mm (2 ft. and 6 in.) diameter and not exceeding 914 mm (3 ft.)	305×229	(12×9)
Boilers over 914 mm (3 ft.) diameter and not exceeding 1067 mm (3 ft. and 6 in.)	356×254	(14×10)
Boilers over 1067 mm (3 ft. and 6 in.) diameter and not exceeding 1219 mm (4 ft.)	381×279	(15×11)
Boilers over 1219 mm (4 ft.)	406×305	(16×12)

TABLE XII/3. Number of Lower Cleaning Holes or Mud Holes

Diameter of boiler	No. of holes
610 mm (2 ft.) and over but not exceeding 914 mm (3 ft.)	3
Over 914 mm (3 ft.) and not exceeding 1524 mm (5 ft.)	4
Over 1524 mm (5 ft.) and not exceeding 1829 mm (6 ft.)	5
Over 1829 mm (6 ft.) and not exceeding 2286 mm (7 ft. and 6 in.)	6
Over 2286 mm (7 ft. and 6 in.) and not exceeding 2591 mm. (8 ft. and 6 in.)	7
Over 2591 mm (8 ft. and 6 in.) and not exceeding 2743 mm (9 ft.)	8

(*ii*) For the figures and words "3½ inches×2½ inches", the following figures, words brackets and abbreviations shall respectively be substituted, namely,

"89 mm×64 mm (3½ in.×2½ in.)"

(267) In Regulation 254, for the figures and words "19/16 inch, 9 inches ×7 inches, 5 inches×3½ inches, 1/16 inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,

"14 mm (9/16 in.)

229 mm×178 mm (9 in.×7 in.)

127 mm×89 mm (5 in.×3½ in.)]

1·6 mm (1/16 in.)

(268) In Regulation 555,

(*i*) for the figures and words "125 pounds per square inch, 1 inch, 3/16 inch, ¼ inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,

8·8 kg/cm² (125 lbs/sq. in.)

25 mm (1 in.)

5 mm (3/16 in.)

6 mm (¼ in.)

(*ii*) in sub-clause (d), for the figures and words "1 inch, 2 inches, 5 inches", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,

"25 mm (1 in.)

51 mm (2 in.)

127 mm (5 in.)"

re 5 inches , the : owing figures, words, abbreviations and brackets shall be substituted, namely,—

"127 mm (5 in.)"

(269) In Regulation 561,

(*i*) in clause (a), for the figure and word "16 feet", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"4877 mm (16 ft.)"

(*ii*) in clause (b), for the figures and words "1/32 inch, 1½ square inch, 1¼ inch, 1/16 inch, 1/8 inch, 20 foot pounds, ½ inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"0·8 mm. (1/32 in.)
9·7 cm.² (1½ sq. in.)
32 mm. (1¼ in.)
1·6 mm. (1/16 in.)
3 mm (1/8 in.)
2·77 kg. metres (20 ft. pounds)
13 mm. (½ in.)"

(*iii*) in clause (c) for the figures and words "1½ square inch, 1/16 inch, 1/8 inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"9·7 cm.² (1½ sq. in.)
1·6 mm. (1/16 in.)
3 mm. (1/8 in.)"

(270) In Regulation 562, in clause (b), the first paragraph namely, the paragraph reading as "the shell thickness in thirty second of an inch exceeds D/3·5+7 where D=internal diameter of the shell in inches" shall be substituted by the following, namely,—

"The shell thickness exceeds $\frac{D}{112}$ + C where D =internal diameter of the shell and C=5·6 mm (7/32 in.)."

(271) In Regulation 563, for the table XII/3, the following table shall be substituted, namely,—

TABLE XII/4

Classification of Fusion Welded Boilers

Classification	Limits of application	Minimum thickness
Class I . .	No limit	6 mm (¼ in.)
Class II .	When the following limits are not exceeded :— *a.* Working pressure—7·4 kg/cm² (105 lbs/sq. in.) *b.* Working pressure × internal diameter=C, Where C=938 when the pressure is in kg/cm² and the diameter is in centimetre. (5250 when the pressure in lbs/sq. in. and the diameter is in inches.)	Boilers upto and including 914 mm (36 in.) internal diameter—8 mm (5/16 in.)
Class I .	When the following limits are not exceeded :— *a.* Working pressure—2·1 kg/cm² (305 lbs/sq. in.) *b.* Working pressure × internal diameter =C Where C= 536 when the pressure is in kg/cm² and the diameter is in centimetre. (3000 when the pressure is in lbs/sq. in. and the diameter is in inches.)	Boilers over 914 mm (36 in.) internal diameter—10 mm (3/8 in.)

"564. Shells.—The working pressure of the cylindrical . be determined by ing formula :

$$W.P. = \frac{(t - C_1) \times SC}{70\ D} \quad \text{.....Equation XII/1.}$$

Where—

t is minimum thickness of shell plate.

P is working pressure.

D is maximum internal diameter

S is minimum tensile strength of plate

C_1 is 0·16 cm (·06 in.)

C is a constant, as given below.

In no case, however, shall the factor of safety of the shell be less than 4 or the plate thickness be less than specified in Table XII/3 given under Regulation 563.

C=32 where Class I requirements are complied with.

C=27 where Class II requirements are complied with.

C=23 for Class III boilers when stress relieved.

C=21 for Class III boilers when not stress relieved.

Where boilers have a nest or nests of horizontal tubes, so that there is a direct tension on the tube plates due to the vertical load on the boiler ends or to tube plates acting as horizontal ties across the shell :

(*i*) each alternate tube in the outer vertical row of tubes shall be a stay tube.

(*ii*) the thickness of the tube plates and the spacing of the tubes shall be such that the section of metal taking the load is sufficient to keep the stress within that allowed on the shell plate, as determined by the following formula :—

$$W.P. = \frac{(t - C_1) \times S \times J}{203\ D} \quad \text{..... Equation XII/2.}$$

Where—

t is thickness of the tube plate,

WP is working pressure,

S is minimum tensile strength of plate.

D is twice the radial distance of the centre of the outer row of tube holes from the axis of the shell.

J is the percentage strength of the plate through the tube holes, *i.e.*

$$\frac{100\ (p - d)}{P} \quad \text{..... Equation XII/3.}$$

P is the vertical pitch of tubes.

d is the diameter of the tube holes.

C_1 is 0·16 cm (·06 in.).

NOTE.—The tube plates between the stay tubes shall comply with the requirements for the tube plates (*see* Reg. 577).

(273) Regulation 565 shall be substituted by the following, excepting the figure XII/61 which should remain as it is :

"565. Horizontal shelves of tube plates forming part of the shell.—The number of gussets equired to support the horizontal shelves of tube plates to withstand the vertical load due to the pressure on the boiler ends shall be determined in the following manner :—

For combustion chamber tube plates the minimum number of the gussets shall be—

C exceeds 26058 when the working pressure is in kg/cm^2 and the diameter and thickness are in centimetre or 145920 when the working pressure is in pounds per square inch and the diameter and thickness are in inches.

..... I g usset

C exceeds 35658 when the working pressure is in kg/cm² and the diameter and thickness are in centimetre or 199680 when the working pressure is in pounds per square inch and the diameter and thickness are in inches.

.....2 gussets.

C exceeds 42506 when the working pressure is in kg/cm² and the diameter and thickness are in centimetre or 238080 when the working pressure is in pounds per square inch and the diameter and thickness are in inches.

..... 3 gussets.

For the smoke box tube plate the minimum number of gussets shall be—

C exceeds 26058 when the working pressure is in kg/cm² and the diameter and thickness are in centimetre or 145920 when the working pressure is in pounds per square inch and the diameter and thickness are in inches.

..... 1 gusset.

C exceeds 48002 when the working pressure is in kg/cm² and the diameter and thickness are in centimetre or 268800 when the working pressure is in pounds per square inch and the diameter and thickness are in inches.

..... 2 gussets.

and $C = \frac{ADP}{t}$ .....Equation XII/4.

Where—

A is maximum horizontal dimension of the shelf from the inside of the shell plate to the outside of the tube plate.

D is inside diameter of the boiler.

P is working pressure.

t is thickness of tube plate.

/ FIG. XII/61. /

The shell plates to which the sides of the tube plates are connected shall be not less han 1·6 mm (1/16 in.) thicker than is required by the formula applicable to shell plates with continuous circularity; and where gussets or other stays are not fitted to the shelves, the strength of the parts of the circumferential seams at the top and bottom of these plates from the outside of one tube plate to the outside of the other, shall be sufficient to withstand the whole load on the boiler end, with a factor of safety of not less than 4·5.

(274) Regulation 566 shall be substituted by the following namely,

566. Dished end plates for Lancashire and Cornish boilers.—For the dished ends of Lancashire and Cornish boilers without stays and subject to internal pressure the maximum working pressure shall be determined by the following formula:

$$W.P. = \frac{(t-C)\times 30S}{70\,R}$$ .....Equation XII/5.

Where—

t is minimum thickness of the end plate.

WP is working pressure.

R is inner radius of curvature of the end plate.

S is minimum tensile strength of the plate.

C is 0·6 cm (0·25 in.).

The inner radius of curvature of the end plate shall not be less than 4 times the thickness of the plate but in no case less than 64 mm (2½ in.) exceed 1½ times the external diameter of the shell to which it is attached.

The inner radius of flanging of the end plate shall not be less than 4 times the thickness of the plate but in no case less than 64 mm (2½ in.).

Where the end plate has a manhole, compensation shall be obtained by flanging the edge of the opening or by providing a fabricated ring (*see* Figure XII/52).

In either case the depth of the flanging or ring measured at the minor axis shall not be less than that determined by the following formula :

$$D = \sqrt{TW}$$ .....Equation XII/6.

Where—

D is depth of flange or ring measured from the outside of the plate to the joint face.

T is thickness of the plate.

W is width of the opening measured on the minor axis.

(275) Regulation 567 shall be substituted by the following, namely:—

"567. Dished ends subject to internal pressure.—For unstayed ends of shells and tops of vertical boilers and the like boiler parts, when dished to partial spherical form the maximum working pressure shall be determined by the following formula :—

$$WP = \frac{15 \times S\ (t - c)}{70\ R} \quad \text{Equation XII/7.}$$

WP is the working pressure.

t is thickness of the end plate but in no case this shall be less than the thickness of the shell to which it is attached.

R is the inner radius of curvature of the end which shall not exceed the external diameter of the shell to which it is attached.

S is the minimum tensile breaking strength of plate or whatever is allowed for it.

C is 0·08 cm. (0·03 in.).

(b) The inside radius to which a crown plate is dished shall be not greater than the external diameter of the cylinder to which it is attached.

(c) The inside radius of curvature of the flanges to the shell shall be not less than 4 times the thickness of the crown plate and in no case less than 64 mm (2½ in.)

(d) The inside radius of curvature of flanges to uptakes shall be not less than twice the thickness of the crown plate and in no case less than 25 mm (1 in.)

(e) When the end has a manhole in it, the value of C shall be taken 0·4 cm (0·156 in.).

(f) The total depth of flange of manhole from the outer surface measured on the minor axis shall be at least equal to—

$$\sqrt{T \times W} \text{ depth of flange} \quad \text{Equation XII/8.}$$

Where T is the thickness of the plate and W is the minor axis of the hole.

(g) The depth of the crown plate opening from the commencement of the curvature of the flanging radius shall be not less than twice the plate thickness with a minimum of 25 mm (1 in.)."

(276) In Regulation 568, Clause (i), the figures and words "2½ inches, one inch", shall respectively be substituted by the following, namely,—

"64 mm (2½ in.)
25 mm (1 in.)"

(277) Regulation 569 shall be substituted by the following, namely,—

569. Hemispherical crowns.—The maximum working pressure for hemispherical crown subjected to internal pressure shall be determined by the following formula :—

$$W.P. = \frac{(t - C_1)\ \ S \times C}{70\ R} \quad \text{Equation XII/9.}$$

Where—

t is thickness of plate.

W.P. is the working pressure.

R is inner radius of curvature.

S is minimum tensile strength of the plate.

C is a constant, as given below.

C1 is 0·16 cm (0·06 in.).

In no case, however, shall the factor of safety of the crown plate be less than 4 nor the plate thickness be less than specified in Table given under Regulation 563.

C=32 where Class I requirements are complied with.

C=27 where Class II requirements are complied with.

C=23 for Class III boilers when stress relieved.

C=21 for Class III boilers when not stress relieved.

(278) In Regulation 571,

(i) the figures and words "2¾ inches, 4 inches, ½ inch, 1/8 inch" shall respectively be substituted by the following, namely:—

"70 mm (2¾ in.)
102 mm (4 in.)
13 mm (½ in.)
3mm (1/8 in.)"

(ii) in clause b(i), the figures and word "2(3 inch +Ts)" shall be substituted by the following namely:—

"$2(C_1+Ts)$

Where,

C_1=76 mm (3 in.)"

(iii) in sub-clause (d), the formulae

$B=2(3+Ts)\ (Ts-T1)$ and

$C=2(4+Ts)\ [Tn-(t_s+Ts)] \times \frac{S_s}{S_d}$

shall be substituted by the following formulae:

"$B=2(C_1+Ts)\ (Ts-T1)$

Where

C_1=76 mm (3 in.)

$C=2(C_2+Ts)\ [Tn-(T_s-Ts)] \times \frac{S_s}{S_d}$

Where

C_2=102 mm (4 in.)

(iv) the words "in inches" and "in tons per square inch" wherever they occur shall be deleted.

(279) In Regulation 572, for the figures and words,

"16 inches, 3/4 inch, 1 inch, 1¼ inch, 1 1/4 inch, 120 pounds per square inch, 200 pounds per square inch, 250 pounds per square inch, 5000 pounds per square inch, 6000 pounds per square inch, 6500 pounds per square inch" shall respectively be substituted by the following figures words, abbreviations and brackets, namely,—

"406 mm (16 in.)
19 mm (3/4 in.)
25 mm (1 in.)
29 mm (1 1/8 in.)
32 mm (1 1/4 in.)
8·4 kg/cm² (120 lbs/sq. in.)
14 kg/cm² (200 lbs/sq. in.)
17·5 kg/cm² (250 lbs/sq. in.)
351·5 kg/cm² (5000 lbs/ sq. in.)
422 kg/cm² (6000 lbs/sq. in.)
457 kg/cm² (6500 lbs/sq. in.)"

(280) In Regulation 573,

(i) for the figure and word "1/2 inch", the following figures, words, abbreviations and bracket shall be substituted, namely,—

"13 mm (½ in.)"

(ii) in clause (b) for the figure and words "360 pounds per square inch", the following figures, words, abbreviations and brackets, shall respectively be substituted , namely,—

"25·3 kg/cm² (360 lbs/sq. in.)"

the e[illegible] shall be [illegible] by

$$t = \frac{D+C}{32} \quad \text{Equation XII/10.}$$

Where,

t is thickness of standpipe.

D is external diameter of standpipe.

C is 5 mm (3/16in.).

Solid forged standpipes shall have a minimum thickness of flange and body in accordance with Table XII/4.

(iv) Table XII/4 shall be substituted by the following table, namely,

TABLE XII/4

Thickness of solid forged standpipes.

Bore of Standpipe		Minimum thickness										
		Design pressure upto and including 11 kg/cm² (160 pounds per square inch.)				Design pressure above 11 kg/cm² (160 pounds per square inch) and upto and including 18 kg/cm² (260 pounds per sq. in.)				Design pressure above 18 kg/cm (260 pounds per sq. in.) upto and including 25 kg/cm² (360 pounds per sq. in.)		
		Flange joining boiler		Body		Flange joining boiler		Body		Flange joining boiler		Bo
mm.	in.	mm.	in.	mm.	in.	mm.	in	mm.	in.	mm.	in.	mm.
25	1	11	7/16	10	3/8	13	1/2	10	3/8	19	3/4	10
32	1-1/4	11	7/16	10	3/8	13	1/2	10	3/8	19	3/4	10
38	1-1/2	11	7/16	10	3/8	13	1/2	11	7/16	19	3/4	13
51	2	11	7/16	10	3/8	14·5	9/16	11	7/16	19	3/4	13
64	2-1/2	11	7/16	10	3/8	14·5	9/16	11	7/16	22	7/8	16
76	3	14·5	9/16	11	7/16	16	5/8	13	1/2	22	7/8	16
89	3-1/2	14·5	9/16	11	7/16	16	5/8	13	1/2	22	7/8	16
102	4	14·5	9/16	11	7/16	16	5/8	13	1/2	22	7/8	16
114	4-1/2	14·5	9/16	11	7/16	16	5/8	13	1/2	22	7/8	16
127	5	16	5/8	14·5	9/16	19	3/4	16	5/8	22	7/8	16
152	6	16	5/8	14·5	9/16	19	3/4	16	5/8	22	7/8	16
178	7	16	5/8	14·5	9/16	19	3/4	16	5/8	22	7/8	16
203	8	16	5/8	14·5	9/16	19	3/4	16	5/8	22	7/8	16
229	9	16	5/8	16	5/8	19	3/4	16	5/8	22	7/8	16
254	10	16	5/8	16	5/8	19	3/4	16	5/8	22	7/8	16
		Perssed place saddle 16mm (5/8 in.)				Pressed plate saddle 19 mm (3/4 in.)				Pressed plate saddle 22 mm (7/8 in.)		

574. Stayed flat surfaces (other than crowns of vertical boilers).—(a) Where flat end plates are flanged for connection to the shell, the inside radius of flanging shall not be less than 1·75 times the thickness of the plate with a minimum of 38 mm (1½ inches).

(b) Where combustion chamber or fire-box plates are flanged for connection to the wrapper the inside radius of flanging shall be equal to the thickness of the plate, with a minimum of 25 mm (1 inch).

(c) Where the flange curvature is a point of support, this shall be taken at the commencement of curvature, or at a line 3½ times the thickness of the plate measured from the outside of the plate whichever is nearer to the flange.

(d) Where a flat plate is welded directly to a shell or wrapper, the point of support shall be taken at the inside of the shell or wrapper.

(e) The working pressure of flat plates supported by stays, shall be determined by the following formula :

$$WP = \frac{C(t-C1)^2}{A^2+B^2} \quad . \quad . \quad . \quad . \quad . \quad \text{Equation XII/11.}$$

Where

t is thickness of plate.

WP is working pressure.

A is horizontal pitch of stays.

B is vertical pitch of the stays.

C1 is 0·08 cm (0·03 inch).

C is constant, as given below.

The constants given below relate to plates which are stress relieved and not exposed to flame.

When plates are exposed to flame the constants shall be reduced by 12½ per cent.

Where various forms of support are used Constant C shall be the mean of the values for the respective method, adopted.

Where stays are irregularly pitched, D_s shall be taken instead of A^2+B^2, D being the diameter of the largest circle which can be drawn with the circumference passing through three points of support without enclosing another point of support. No more than two points of support may be located on one side of any diameter of the circle.

The value of the Constant C in Equation XII/11 shall be as follows :

(i) Where stays are screwed through the plates and, in addition, are fillet welded to the plates on the outside, the size of the weld being 0·25 of the diameter of the screwed portion of the stays (*see* Figure XII/39).

C= 4103 kg/cm^2 (58368 lbs/in.^{2})

(ii) Where stays are screwed through the plates and, in addition, are fillet welded to the plates on the outside, the size of the weld being 0·35 of the diameter of the screwed portion of the stays (*see* Fig. XII/40).

C=5759 kg/cm^2 (81920 lbs/in.^{2})

(iii) Where plain stays are strength welded into the plates (*see* Figure XII/41).

C=5759 kg/cm^2 (81920 lbs/in.^{2})

(iv) Where plain bar stays pass through holes in the plates and are secured as shown in Figure XII/42.

C=6479 kg/cm^2 (92160 lbs/in.^{2})

(v) Where plain bar stays pass through holes in the plates and are fitted on the outside with washers and are secured as shown in Figures XII/43(a), XII/43(b).

C=7199 kg/cm^2 (102400 lbs/in.^{2})

(vi) Where plain bar stays pass through holes in the plates and are fitted on the outside with washers as shown in Figures XII/44(a), XII/44(b), XII/45(a) and XII/45(b).

C=7919 kg/cm^2 (112640 lbs/in.^{2})

(vii) Where plain bar stays pass through holes in the plates and are fitted on the outside with washers as shown in Figures XII/46(a), XII/46(b).

C=8639 kg/cm^2 (122880 lbs/in.^{2})

(viii) Where the flat plate is flanged for attachment to the shell, flue or wrapper (*see* Sub-regulation (c) above).

C=7919 kg/cm^2 (112640 lbs /in.^{2})

(ix) Where the flat plate is welded directly to the shell, flue or wrapper (*see* Sub-regulation (d) above).

C=7919 kg/cm² (112640 lb./in.²)

(x) Where the support is a gusset or link stay;

C= 5759 kg/cm² (81920 lb./in.²)

(xi) For the lower portion of the front end plate of a Lancashiere boiler containing the manhole, the values of D and C to be used in Equation XII/11 shall be as follows :—

D=diameter of the largest circle which can be drawn enclosing the manhole and passing through the points of support formed by the gusset stays and the connection to the shell and furnaces. Where the circle passes through only three of the possible five points of support mentioned, the remaining two shall be included within the circle.

C=21597 kg/cm² (307200 lb./in.²)

(xii) In Cornish boilers where it is necessary to strengthen the portion of the end plate outside the wing gussets, suitable section stiffeners shall be secured to the plates by full fillet welds within circle D, and the appropriate constant C shall be increased by 30 per cent. The stiffeners shall be placed in such a position, and the section used shall be such, that:—

(i) The unstayed area will be approximately equally divided.

(ii) The load will be transmitted at each end as directly as possible to the gusset stays of other supporting boundaries.

(iii) The thickness of the vertical rib of any tee bar stiffener shall be not less than the thickness of the end plate.

(f) In the case of smaller boilers where the end plates are supported in the steam space by a single substantial tee bar [continuously fillet welded to the plate with not les than 10 mm (3/8 inch) fillet welds] extending across the plate to the commencement of curvature of the flange or the toe of the fillet weld securing the end plate to the shell, or where such plates are supported with a deep bulb extending across the plates as described above, the thickness of the plate shall be determined by the Equation XII/11 the values of D and C being as follows :—

(i) For the portion of the plate above the stiffeners : -

D is diameter of the largest circle passing through the centre of the tee or bulb and the commencement of flange curvature of the inside of the shell, whichever is applicable :

C=5759 kg/cm² (81920 lbs./in.²)

(ii) For the portion of the plate below the stiffeners :

D is diameter of the circle passing through the centre of the tee or bulb and two adjacent screwed stays:

C=3960 kg/cm² (56320 lbs./in.²)

or

D is diameter of the circle passing through the centre of the tee or bulb and the centre line of the top row of tubes :

C=2520 kg/cm² (35840 lbs./in.²)

(282) In Regulation 575,

(i) for the figures and words "2½ inches, 1 inch," the following figures, words, abbreviations and brackets, shall respectively be substituted, namely,—

"64 mm (2½ in.)

25 mm (1 in.)"

(ii) the words "In inches" wherever they occur shall be deleted.

(iii) the letter and figure "C=55" shall be substituted by the following letter, figure, abbreviation and bracket :

"C=3960 kg/cm² (56320 lbs./in.²)"

(283) In Regulation 576, equation XII/12, shall be substituted by the following equation, namely,—

$$W.P.=\frac{C(t-C_1)^2}{A^2+B^2} \quad \ldots\ldots\ldots\ldots \text{Equation XII/12.}$$

Where

t is thickness of the tube plate.
WP is working pressure.

A is width of the wide water space between the tube nests (measured at the centre line of the stay tubes).

B is pitch of the stay tubes in the boundary rows of the width water space.

C_1 is 0·08 cm (0·03 in.)

Where the stay tubes are welded to the tube plates in accordance with Figure XII/67 or XII/68 with tubes lightly expanded before welding.

C=4031 kg/cm² (57344 lbs./in.²) if the plates are exposed to flame.

C=4607 kg/cm² (65536 lbs./in.²) if the plates are not exposed to flame.

Where the stay tubes are welded to the tube plates in accordance with figure XII/69 with tubes lightly expanded before welding:

C=5039 kg/cm² (71680 lbs./in.²) if the plates are exposed to flame.

C=5759 kg/cm² (81920 lbs./in.²) if the plates are not exposed to flame.

Where the stays are irregularly pitched D^2 shall be taken instead of (A^2+B^2) where D is the diameter of the largest circle which can be drawn through any three points of support without enclosing another point of support (See Figures XII/74, XII/75, XII/76 and XII/77). Where various forms of supports are used, the value of C shall be the mean of the values for the respective methods adopted. At the attachment of the end plate to shell, furnaces of flues, the point of support and the constant C to be used shall be taken in accordance with Regulation 574.

For the portions of the end plates between the top rows of tubes and the steam space stays Equation XII/12 shall apply, B being taken as the distance between the centre line of the top rows of tubes and the centre of the bar stays or other point of support and A being taken as

$$\frac{A_1+A_2}{2}$$

Where,—

A_1 is the distance between the centres of bar stays or other method of support, and

A_2 is the horizontal distance from the centre of one stay tube and the centre of the next stay tube in the top boundary row. Where no stay tubes are fitted A_2 shall be taken as equal to four times the horizontal pitch of the plain tubes. Where no stay tubes are fitted the support afforded by the plain tubes shall not be taken to extend beyond the line enclosing the outer surfaces of the tubes except that, between the outside of the wing row of tubes and the attachment of the end plate to shell there may be an unsupported width equal to the flat plate margin as given by Equation XII/23.

(284) In Regulation 577,

(i) in clause (a),

(i) for the figures and words, "7 square feet, 21 square feet", the following figures, words abbreviations and brackets, shall respectively be substituted, namely,—

6503 sq. cm. (7 sq. ft.)

19509 sq. cm. (21 sq. ft.)

(ii) Equation XII/13 shall be substituted by the following, namely,—

$$WP=\frac{C\,(t-C_1)^2}{M^2} \quad \text{.....Equation XII/13.}$$

Where—

t is thickness of the tube plate.

WP is working pressure.

M is mean pitch of the stay tubes—being the sum of the four sides of any quadrilateral bounded by four quadrilateral adjacent stay tubes divided by 4.

C_1 is 0·08 cm (0·03 in.)

C is 4031 kg/cm² (57344 lbs./in.²) for plates exposed to flame.

4607 kg/cm² (65536 lbs./in.²) for plates not exposed to flame.

Stay tubes secured in accordance with Figure XII/67 or XII/68.

C=5039 kg/cm² (71680 lbs./in.²) for plates exposed to flame

C=5759 kg/cm² (81920 lbs./in²) for plates not exposed to flame.

Stay tubes secured in accordance with Figure XII/69.

In clause (b),

(i) for the figures and words "7 square feet and 21 square feet", the following figures, abbreviations and brackets shall respectively be substituted, namely,—

"6503 sq. cm. (7 sq. ft.)

19509 sq. cm. (21 sq. ft.)"

(ii) the words "in inches" wherever they occur in the Regulation shall be deleted.

(iii) the letter and figure "C=50, C=60" shall respectively be sbustituted by the following namely,—

"C=3600 kg/cm^2 (51200 lbs./ln.^{2})"

C=4319 kg/cm^2 (61440 lbs./in.^{2})

(285) In Regulation 578,

(i) for the figure and word "1/8 inch", the following figures, word, bracket and abbreviation shall be substituted,

"3 mm (1/8 In.)"

(ii) the words "in inches" wherever they occur shall be deleted.

(iii) the figures and words "7 feet and 6 inches" shall be substituted by the following figures words, abbreviations and brackets, namely,—

2286 mm (7 ft. and 6 in.)

(286) In Regulation 579,

(i) in clause (b), Equation XII/14 shall be substituted by the following, namely,—

$$WP = \frac{C\,(t - C_1)}{D} \qquad \text{.....Equation XII/14.}$$

Where

t is thickness of the tubes

D is external diameter of the tube.

C is 703 kg/cm.^{2} (10,000 lbs./in^2)

C_1 is 0·16 cm. (0·06 in.)

No tube shall be less than 2·64 mm (0·104 in. thick).

(ii) in clause (c) equation XII/15 shall be substituted by the folloing, namely,

$$WP = \frac{C\,(t - C_1)}{D} \qquad \text{.....Equation XII/15.}$$

Where

t is minimum thickness of tube

WP is working pressure.

D is outside diameter of tube

C is 984 kg/cm^2 (14000 lbs./in^2)

C_1 is 0·25 cm. (0·1 in.)

(287) Regulation 580 shall be substituted by the following, namely,—

"580. Pitch of tubes.—The spacing of tube holes shall be such that the minimum width any ligament between the tube holes shall be not less than:—

$$\frac{D}{8} + C$$

Where

C= 13 mm ($\frac{1}{2}$ in.)

alernatively,

the thickness and cross-section of the plate between the tube holes shall be not less than 0·125 D+C=minimum thickness.

Where

C= 5 mm (0·2 in.)

KD+C_1=minimum cross-section where D is diameter of the tube hole.

K=4·3 mm (0·17 In.)

C_1=16·13 mm.^{2} (0·025 in.^{2})

In no case shall be the minimum thickness of any tube plate in the tube area be less than the

limits:—

T = 13 mm (½ in.) Where the diameter of the tube hole does not exceed 51 mm (2 in.)

T = 14 mm (9/16 in.). Where the diameter of the tube hole is greater than 51 mm (2 in.)"

(288) Regulation 581 shall be substituted by the following, namely,—

"581. Stay tubes.—Stay tubes shall be of steel, seamless or electrically resistance welded.

(a) Minimum thickness of stay tubes. —Minimum thickness of stay tubes shall be such that the stress on the net cross-sectional area either at the bottom of the threaded part or at the middle of the tube whichever is the lesser shall not exceed 527 kg/cm.² (7500 lbs. per sq. in.). Thickness of stay tubes at any part shall not be less than 5 mm (3/16 in.).

(b) The maximum working pressure for screwed in stay tubes shall be calculated by the following formula :

$$WP = \frac{C}{A} - [(D - C_1)^2 - D_1^2] \quad . \quad . \quad . \quad . \quad \text{Equation XII/16.}$$

D is diameter of the stay tube over threads.

D_1 is internal diameter of the tubes under the threads.

$C_1 = 1 \cdot 299$ Pcm., P being the pitch of thread in cm.

C $\frac{1 \cdot 28}{N}$ (inch, N being the number of thread per inch).

C = 415 kg/cm² (5900 lbs/in.²)

A is the area supported by one stay tube, measured from centre to centre of stay tubes. When the area contains tubes or parts of tubes their aggregate area, calculated from their smallest external diameter of body when in tension and smallest internal diameter when in compression, shall be deducted from the area of the containing figure and the remainder used as A in the formula.

Where stay tubes have their thickness increased at the screwed ends to provide for plus threads, the increased thickness shall be obtained by upsetting and not by welding, and the tubes shall be subsequenrly annealed.

Stay tubes may be attached to the tube plates either by screwing or by metal arc welding.

Where stay tubes are screwed into the tube plates they shall be screwed with a continuous thread of pitch not less than 2·5 mm at both ends and shall be expanded into the tube plates, by roller expander and, if desired, may be seal welded.

Welded attachment of stay tubes be as shown in Figures XII/67, XII/68 and XII/69."

(289) Regulation 582 shall be substituted, by the following, namely,

"582. Compression of tube plates.—(a) For fire-box or combustion chamber tube plates which are subject to compression due to the pressure on the roof plate, the maximum working pressure shall be :

$$WP = \frac{C \times (P - D) \times t}{L \times P} \quad . \quad . \quad . \quad . \quad \text{Equation XII/17.}$$

t is thickness of the tube plate.

P is pitch of the tubes measured horizontally where the tubes are chain pitched, or diagonally where the tubes are zigzag pitched and the diagonal pitch is less than the horizontal.

D is internal diameter of the plain tubes.

L is internal length of the fire-box or combustion chamber measured at top between tube plate and firehole plate or back plate, or between tube plates in double ended boilers with combustion chambers common to two opposite furnaces,

C = 1969 kg/cm² (28,000 lbs/in.²)

Provided that the above formula shall not apply in the cases of fire boxes where the girders do not rest on the tube plate, or where the roof plate is stayed direct to the outer shell or to girders supported by the shell.

(b) Where girders rest on the side plates or the roof plate is so formed that the load is carried both by side and end plates, the compressive stress on the plates shall not in either case exceed 984·5 kg/cm² (14,000 lbs./sq. in.)."

(290) Regulation 583, shall be substituted by the following, namely,—

"583. Girders for firebox and combustion chamber crowns.—(a) For girders supporting crown plates of rectangular fireboxes, where the ends of the girders are supported by the vertical end or side plates, their proportions shall be calculated by the following formula :

$$WP = \frac{GST\ d^2}{L^2\ Y} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Equation XII/18.}$$

Where

WP is working pressure.

S is Minimum tensile stress of the material.

T is total thickness of the stay.

d is depth of the girder stay.

L is length of girder stay measured between the inside of the tube plate and the firehole plate; or between the inside side plates, according to the method of support.

Y is pitch of girder.

C=0·314 for steel plates or steel forgings,

=0·271 for steel castings.

(b) Where girders are welded to the crown plate the dimensions of the welds shall be such that the stress calculated on an area equal to the sum of the effective lengths of the welds attaching each girder multiplied by the effective throat thickness shall not exceed 527·3 kg/cm^2 (7500 lbs/sq. in.) multiplied by the appropriate weld factor in Table XII/7 ("effective length" and "effective throat thickness" are defined in Regulation 591). The load on the welds shall be taken as that due to the design pressure acting on the area LY; L and Y being as defined in Regulation 583".

(291) Regulation 584 shall be substituted by the following, namely,—

"584. Girder sling stays.—For slung girders the proportion of sling, links pins and connections to the shell shall be sufficient to carry the whole load that would otherwise be carried on toes of the girders and for any of the above parts in tension as stress of 632·7 kg/cm.^{2} (9,000 pounds per square inch) of net section, and for parts in shear a stress of 562·4 kg/ cm^2 (8000 pounds per square inch) of net section shall not be exceeded. In the case of parts in double shear, the net area of the section should be taken as 1·875 times the single section."

(292) Regulation 585 shall be substituted by the following, namely,—

"585. Stays for fireboxes and circular furnaces.—(a) Solid screwed stays.—For screw stays to combustion chambers and fireboxes and for longitudinal and cross stays, the maximum working pressure for the stays is to be calculated from the appropriate one of the following two formulae:—

$$W.P = \frac{C\,(D - C_1)^2}{A} \quad . \quad . \quad . \quad . \quad . \quad \text{Equation XII/19.}$$

$$\frac{C\,D_1{}^2}{A} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Equation XII/20.}$$

W.P. is the working pressure.

D is diameter of stays over threads.

D1 is diameter of body of stay at its smallest part.

A is area supported by one stay for area to be supported by stays near tubes in firebox tube plates of locotype boilers, *See* Regulation 193(a).

C=499 kg/cm^2 (7100 lbs./in.^{2})

C=607 kg/cm^2 (8640 lbs./in.^{2})

C=330 kg/cm^2 (4700 lbs./in.^{2})

C=1·299 P cm, P being the pitch of threads

or ($\frac{1{\cdot}28}{N}$ inches, N being the number of threads per inch.)

Where stays are made with enlarged ends and the body of the stay is smaller in diameter than at the bottom of the thread, the working pressure shall be calculated from the second formula.

(b) Circumferential stays for circular furnaces and fireboxes.—The diameter of the stay shall be not less than 19 mm (3/4 inch) or twice the thickness of the firebox plate, whichever is the greater. In the case of screwed threads the diameter shall be measured over the threads.

The pitch of the stays at the firebox shall not exceed 14 times the thickness of the firebox plates".

(293) In Regulation 586, the words and figures 4 feet and 6 inches, shall be substituted by the following figures, words, abbreviations and brackets, namely,—

"1372 mm (4 ft. and 6 in.)"

(294) In Regulation 587 shall be substituted by the following, namely,—

"587. Longitudinal Bar Stays.—The maximum working pressure for longitudinal bar stays is to be calculated from the appropriate one of the following two formulae:—

$$W.P. = \frac{C}{A}(D - C_1)^2 \quad \text{. . . . . Equation XII/21.}$$

$$W.P. = \frac{C \times D_1^2}{A} \quad \text{. . . . . Equation XII/22}$$

$W.P.$ is working pressure.

D is diameter of stays over threads.

D_1 is diameter of body of stays at its smallest part.

A is area supported by one stay.

$C_1 = 1 \cdot 299$ P cm, P being the pitch of threads

or $\left(\frac{1 \cdot 28}{N}\right.$ inches, N being the total number of threads per inch.)

C is values given in table below :

TABLE XII/6

Stress on Longitudinal Bar Stays

Range of tensile strength of bar		Value of C	
kg/mm²	tons/in.²	kg/cm²	lbs./in.²
41-47	26/30	552	7850
44-50	28/32	607	8640
47-53	30/34	662	9420
50-56	32/36	717	10200

Where bar stays are fitted in vertical boilers, not less than four bar stays shall be fitted to boilers of 1219 mm (4 feet) and over but under 1524 mm (5 feet) in diameter ; five bar stays to boilers of 1524 mm (5 feet) and over but under 1829 mm (6 feet) in diameter; six bar stays to boilers of 1829 (6 feet) and over in diameter.

In no case, shall the diameter of the stay at any part be less than 25 mm (1 inch). Where joined stays are fitted, the strength of the knuckle joint employed shall be at least equal to the strength of the remainder of the bar stay."

(295) In Regulation 588, the words "in inches" and "in square inches" wherever they occur shall be deleted.

(296) Regulation 589 shall be substituted by the following, namely,—

"589, Flat plate Margins.—The amount of support in relief of the stays which may be attributed to the shell, furnaces or flues to which flat plates are attached shall not exceed that determined by the following formulae:

$$(\text{Width of margin})^2 = W^2 = \frac{C(t - C_1)^2}{W.P.} \quad \text{. . . Equation XII/23.}$$

t is plate thickness.

W.P. is working pressure.

C=867 kg/cm² (12,330 lbs./in.²) for plates exposed to flame.

C=986 kg/cm² (14,018 lbs./in.²) for plates not exposed to flame.

C_1=0·08 cm. (0·03 in.)

Where the plates are flanged, the margin shall be measured from the commencement of curvature of flanging, or from a line 3-1/2 times the thickness of the plate measured from the outside of the plate, whichever is nearer to the flange. Where the flat plate is not flanged for attachment to the shell or flue tubes and is welded as shown in figures XII/12 or XII/16, the width of the margin shall be measured from the inside of the shell or the outside of the flue tube, whichever is applicable.

In no case, however, shall the diameter D of the circle forming the boundary of the margin supported by the uptake of a vertical boiler be greater than that found by the following formula :—

$$D = \frac{\sqrt{CA}}{W.P.} + d^2 \quad . \quad . \quad . \quad . \quad . \quad \text{Equation XII/24.}$$

A is cross sectional area of the uptake tube.

WP is working pressure.

d is external diameter of uptake.

C = 351 kg/cm.^{2} (5000 lbs./sq. in.)."

(297) In Regulatiom 590,

(*i*) Table XII/6 shall be substituted by the following table, namely,—

TABLE XII/7

Breathing Space

Thickness of end plate		Dimension 'L'	
mm.	in.	mm.	in.
13	1/2	254	10
14·5	9/16	279	11
16	5/8	305	12
18	11/16	330	13
19	3/4	330	13
20·6	13/16	330	13
Over 20·6	Over 13/16	343	13-1/2

(*ii*) The figures and words "8 inches, 6 inches and 4-1/2 inches," shall respectively be substituted by the following figures, words, abbreviations and brackets, namely,—

"203 mm (8 inches)

152 mm (6 inches)

114 mm (4-1/2 inches)"

(298) In Regulation 591,

(*i*) In clause (*b*), the figure and word "7/16 inch" shall be substituted by the following figures, words, abbreviations and brackets, namely,—

"11 mm (7/16 in.)"

(*ii*) In clause (*d*) for the figures and words "8,000 pounds per square inch, 1/2 inch", the following figures, words, abbreviations and brackets shall respectively be substituted, namely,—

"562 kg/cm^2 (8,000 lbs./sq. in.)

13 mm (1/2 in.)"

(299) In Regulation 592, clauses (*a*), (*b*) & (*d*) shall respectively be substituted by the following, namely,—

"(*a*) Plain furnaces.—The working pressure of plain furnaces shall be lesser of the two obtained by the use of the following formulae :

$$W.P. = \frac{C}{D}\left[\frac{(t - C_1)}{(L + C_2)}\right] \quad . \quad . \quad . \quad . \quad \text{Equation XII/25.}$$

$$W.P. = \frac{C_3}{D}[320\,(t - C_1) - L] \quad \text{.....Equation XII/26.}$$

t is minimum thickness of plate.

D is external diameter of furnace or flues.

W.P. is working pressure.

L is length of section between centres of points of substantial support (see Figures XII/21, XII/22, XII/23, XII/24 and XII/25).

$C = 104392$ kg/cm^2 (1484800 lbs./in.^{2})

$C_1 = 0{\cdot}08$ cm. (0·03 in.)

$C_3 = 61$ cm. (24 in.)

$C_3 = 3{\cdot}5$ kg/cm^2 (50 lbs./sq. in.)

The thickness of any plain furnace or flue section shall not exceed 22 mm (7/8 in.) or be less than 10 mm (3/8 inch.).

(*b*) Stiffeners.—Where stiffeners are used as shown in figures XII/21 and XII/22, the moment of inertia of the stiffener shall be not less than that required by the following formula :—

$$I = \frac{0{\cdot}14D^2PL}{E} \quad \text{.....Equation XII/27.}$$

Where

D is external diameter of flue.

P is working pressure.

L is length of section between centres of points of substantial support.

E is modulus of elasticity at the design temperature of the metal 1954530 kg/cm^2 ($27{\cdot}8 \times 10^6$).

I is moment of inertia of stiffening ring about its neutral axis.

(*d*) Corrugated furnaces of horizontal boilers.—The maximum working pressure to be allowed on corrugated furnaces shall be determined by the following formula :—

$$W.P. = \frac{C}{D}(t - C_1) \quad \text{.....Equation XII/28.}$$

W.P. is working pressure.

D is the least external diameter measured at the bottom of the corrugations on the water side.

t is the thickness of the furnace plate measured at the bottom of the corrugation or chamber.

C = 1080 kg/cm^2 (15360 lbs./in.^{2}) for the Fox, Morrison, Deighton, and other similar furnaces,

and

1147 kg/cm^2 (16320 lbs./sq. in.) for the Leeds Forge Bulb Suspension Furnace.

$C_1 = 0{\cdot}08$ cm (0·03 in.)

No corrugated furnace shall be more than 22 mm (7/8 in.) or be less than 10 mm (3/8 in.) thick. The depth of corrugations plus the thickness of the plate shall be not less than 51 mm (2 in.)."

(300) In Regulation 593,

(*i*) the words "in inches" wherever they occur shall be deleted.

(*ii*) the figures and words "7/8 inch, 2 feet and 6 inches, 5/16 inch, 3/8 inch" shall respectively be substituted by the following figures, words, abbreviations and brackets namely,—

"22 mm (7/8 in.)

762 mm (2 ft. and 6 in.)

8 mm (5/16 in.)

10 mm (3/8 in.)"

(301) In Regulation 594, Equation XII/29 shall be substituted by the following, namely,—

$$\text{"}W.P. = \frac{C\,(t - C_1)}{D} \quad \text{.....Equation XII/29.}$$

W.P. is working pressure.

t is thickness of the firebox plate.

D is mean of the external diameters of firebox measured over the plain part at each end at commencement of curvature of flange.

C=877 kg/cm² (12480 lbs/sq. in.)

C_1=0·08 cm (0·03 in.)

No corrugated furnace shall be less than 10 mm (3/8 in.) thick."

(302) In Regulation 595, Equation XII/30 shall be substituted by the following, namely,—

"$W.P.=\frac{C(t-C_1)}{R}$ ....Equation XII/30.

W.P. is working pressure.

t is thickness of the top plate.

R is outer radius of curvature of the furnace.

C=619 kg/cm² (8800 lbs/sq. in.)

C_1=0·08 cm (0·03 in.)

The thickness of these furnaces shall in no case exceed 22 mm (7/8 in.)."

47. In Regulation 596, Equation XII/31 shall be substituted by the following, namely,—

" $W.P.=\frac{C\ (t-C_1)^2}{D\ (D-D_1)}$ .....Equation XII/31.

Where

W.P. is working pressure.

t is thinckess of the joggled firebox plate or Ogee ring.

D is inside diameter of the boiler shell.

D_1 is outside diameter of the joggled firebox at the commencement of curvature above joggled part or the outside diameter of the firebox where it joins the ogee ring.

C=10079 kg/cm² (143360 lbs./sq. in.) for Ogee rings (see Figures XII/26 and XII/27).

C=7199 kg/cm² (102400 lbs./sq. in.) where 'U' ring section is used. (see Figures XII/28).

C_1=0·08 cm (0·03 in.)."

(303) In Regulation 597, Equation XII/32 shall be substituted by the following, namely,—

"$W.P.=\frac{C\ (t-C_1)^2\ (L+W)}{LW(W-W_1)}$ .....Equation XII/32.

Where

W.P. is working pressure.

t is thickness of the joggled firebox side plates or fire hold plate (whichever is less), or ogee ring.

L is length of firebox casing measured between the water sides of front end plate and saddle plate at the foundation seam.

*W is width of fire-box casing meaured between the watersides of casing side plates at the foundation seam.

*W_1 is width of firebox measured between the water sides of firebox side plates at the commencement of curvature above joggled part or where it joins the ogee ring.

C=5040 kg/cm² (71680 lbs/sq. in.)

C_1=0·08 cm (0·03 in.)

Where only a compratively narrow strip of the firebox roof is stayed directly to the casting crown the area so stayed shall be deducted from the area represented by L × W in the bottom line of the formula thus : (L × W-A) (W—W1) and so used in Equation XII/32 in determing the working pressure for the parts. "A" being the area of the part of roof supported, by the casting crown."

(304) In Regulation 598, Equation XII/33 and Equation XII/34 shall, respectively be substituted by the following, namely,—

(i) When an internal liner is not fitted :—

$$W.P. = \frac{C(t-C_1)}{D} \quad \text{..... Equation XII/33.}$$

(ii) When an internal liner is fitted extending below the low water levels :—

$$\frac{C_2}{D} \times \frac{(t-C_2)^2}{(L+C_4)} \quad \text{.....Equation XII/34.}$$

Where

WP is working pressure.

t is thickness of the uptake.

D is external diameter.

L is length of the uptake measured between the circum ferential seams.

$C = 225$ kg/cm^2 (3200 lbs/sq. in.)

$C_1 = 0 \cdot 16$ cm. (0·06 in.)

$C_2 = 0 \cdot 08$ cm. (0·03 in.)

$C_3 = 52196$ kg/cm^2 (6742400 lbs./sq. in.)

$C_4 = 61$ cm. (24 in.)

In no case shall the thickness of an uptake tube be less than 10 mm (3/8 in.)".

(305) Regulation 599, shall be substituted by the following, namely,—

"599. Cross Tubes.—Internal diameer of cross tubes shall not exceed 305 mm (12 inches. The working pressure of the tubes shall be determined by the following formula :—

$$W.P. = \frac{C(t-C_1)}{D} \quad \text{.....Equation XII/35.}$$

t is thickness of the cross tube.

D is internal diameter of the cross tube.

$C = 450$ kg/cm^2 (6400 lbs./sq. in.)

$C_1 = 0 \cdot 56$ cm. (0·218 in.)

In no case shall the thickness of a cross tube be less than 8 mm (5/16 in.).

(306) In Regulation 600, the words "in inches" and "in square inches" wherever they occu shall be deleted.

(307) In Regulation 601, the figure and words "50 pounds per square inch" shall be substituted by the following figures, words, abbreviations and brackets:—

"3·5 kg/cm^2 (50 lbs/sq. in.)"

308. In the Addendum,

(i) in figures XII/1 to XII/92, for the figures and abbreviations, "1/16 in., 1/8 in., 3/16 in. 1/4 in., 5/16 in., 3/8 in., 1/2 in., 5/8 in.,3/4 in., 1 in., 1-1/4 in.,1-1/2 in., 1-3/4in., 1-7/8 in., 2 in., 2-1/4 in., 2-3/8 in., 2-1/2 in., 2-5/8 in., 3 in., 3-1/4in., 4 in., 5 in., 5-1/2in., 7 in., 7-1/2 in., 9 in., 4 ft., 4ft. and 6 in." the following figures, abbreviations and brackets shall respectively be substituted/ namely,—

" 1·6 mm	(1/16 in.)
3 mm	(1/8 in.)
5 mm.	(3/16 in.)
8 mm	(5/16 in.)
10 mm	(3/8 in.)
13 mm	(1/2 in.)
16 mm	(5/8 in.)
19 mm	(3/4 in.)
25 mm	(1 in.)
32 mm	(1-1/4 in.)
38 mm	(1-1/2 in.)
44 mm	(1-3/4 in.)
48 mm	(1-7/8 in.)

51 mm	(2 in.)
57 mm	(2-1/4 in.)
61 mm	(2-3/8 in.)
64 mm	(2-1/2 in.)
67 mm	(2-5/8 in.)
76 mm	(3 in.)
83 mm	(3-1/4 in.)
102 mm	(4 in.)
127 mm	(5 in.)
140 mm	(5-1/2 in.)
178 mm	(7 in.)
191 mm	(7-1/2 in.)
229 mm	(9 in.)
1219 mm	(4 ft.)
1376 mm	(4 ft. and 6 in.)

(ii) In Figures XII/67 and XII/68, for the figures and abbreviations "C=56 and C=64", the following figures, abbreviations and brackets shall respectively be substituted, namely,—

C=4031 kg/cm^2 (57344 lbs/sq. in.)

and C=4607 kg/cm^2 (65536 lbs./sq. in.)

(iii) In Figure XII/69, for the figures and abbreviations "C=70 and C=80", the following figures, abbreviations and brackets shall respectively be substituted, namely,—

C=5039 kg/cm^2 (71680 lbs/sq. in.)

and C=5759 kg./cm^2 (81920 lbs/sq. in.)

309. In Appendix A, for the figures and abbreviations "1 in., 1/2 in., 3/8 in., 5/16 in., 3/16 in., 1/8 in., 1/16 in., the following figures, abbreviations and brackets shall respectively be substituted, namely,—

25 mm	(1 in.)
13 mm	(1/2 in.)
10 mm	(3/8 in.)
8 mm	(5/16 in.)
5 mm	(3/16 in.)
3 mm	(1/8 in.)
1·6 mm	(1/16 in.)

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